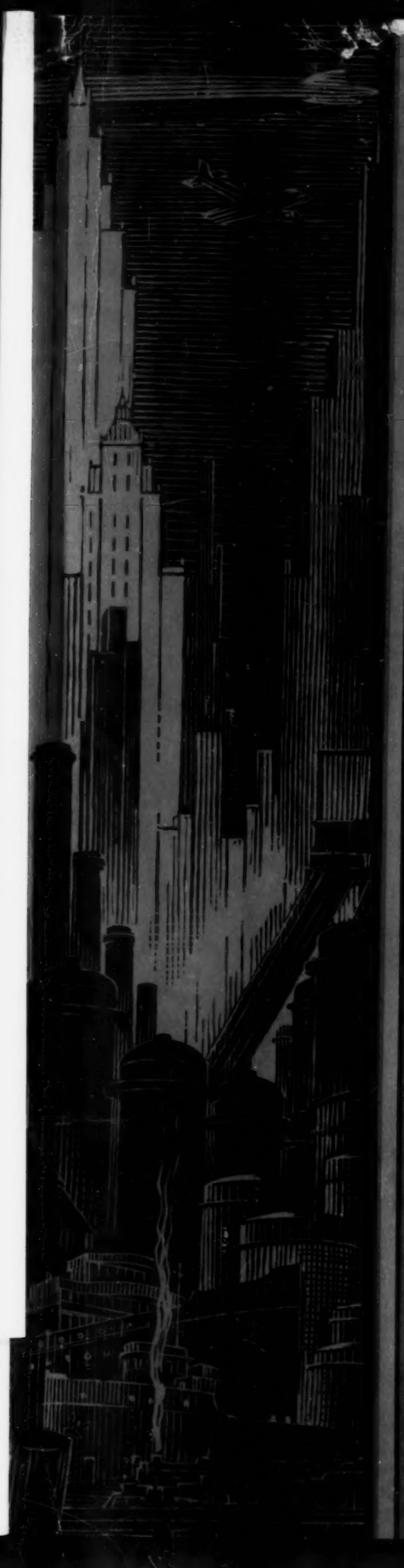

METAL PROGRESS

SEPTEMBER × 1930

AMERICA'S LARGEST CAPACITY FOR MAKING ENDURO

THE PERFECTED STAINLESS STEEL

Tapping a twenty-five ton Electric Furnace in one of the two modern plants in which Republic produces Enduro Nirosta KA2, the perfected Stainless Steel—under the original Krupp patents.

JUST two years ago Republic's alloy division first made Enduro Nirosta KA2 available to American industry. Even in this brief period, demand for this perfected stainless steel has become so widespread that Republic's capacity for its production, already the largest in the world, is now being still further increased.

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The glittering tower of New York's mammoth Chrysler Building is sheathed in Enduro. Pilasters of the even taller new Empire State Building will be covered with this same fascinating alloy.

Enduro is stronger than carbon steel—impervious to rust, corrosion and the vicious attacks of most acids. Yet it is easy to work. The gleaming finish cannot wear thin or chip off because, unlike a plated surface, it is the same all the way through.

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A stainless metal with such remarkable properties will greatly increase the usefulness, appearance and profitable saleability of hundreds of products in hundreds of fields. Republic metallurgists will gladly work with any manufacturer in adapting Enduro to new needs and new uses.

REPUBLIC STEEL
CORPORATION

GENERAL OFFICES: YOUNGSTOWN, OHIO

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Ernest E. Thum, Editor

Metal Progress

Published by the American Society for Steel Treating

TABLE OF CONTENTS

ELECTRIC STEEL .. 32
WELDED PIPE .. 33
GUN TUBES .. 38
PRESSURE METALS .. 40
NITRIDED CASE .. 46
CORROSION .. 48
BRAZING .. 54
CRACKS .. 57
FURNACE DESIGN .. 58
END OF THE HEAT .. 64
GEARS .. 68
ZRS-4 .. 71
BOILER DRUMS .. 74
NITRIDING PROCESS .. 79
BOLTS .. 85
METAL CONGRESS .. 88
DIE CASTING .. 91
RADIUM .. 96

Authors Page .. 16
Editorials .. 65
Data Sheets
Iron Carbon Diagram .. 81
Aluminum Alloy Constituents .. 83
Correspondence and Foreign Letters .. 99
Recommended Practice Committee Releases .. 104
Engineering Index .. 116
Interesting Articles of the Month .. 124
Round the World .. 131
Patents .. 162
Helpful Literature .. 166
Index to Advertisements .. 201

Timken Alloy Steels
keep pace with changing needs

Design, operating capacities, stress and load requirements in all types of machinery have undergone radical changes during the last few years, necessitating revised specifications in constructional material—principally steel.

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Lighter sections are now required to carry heavier loads and to withstand greater shocks.

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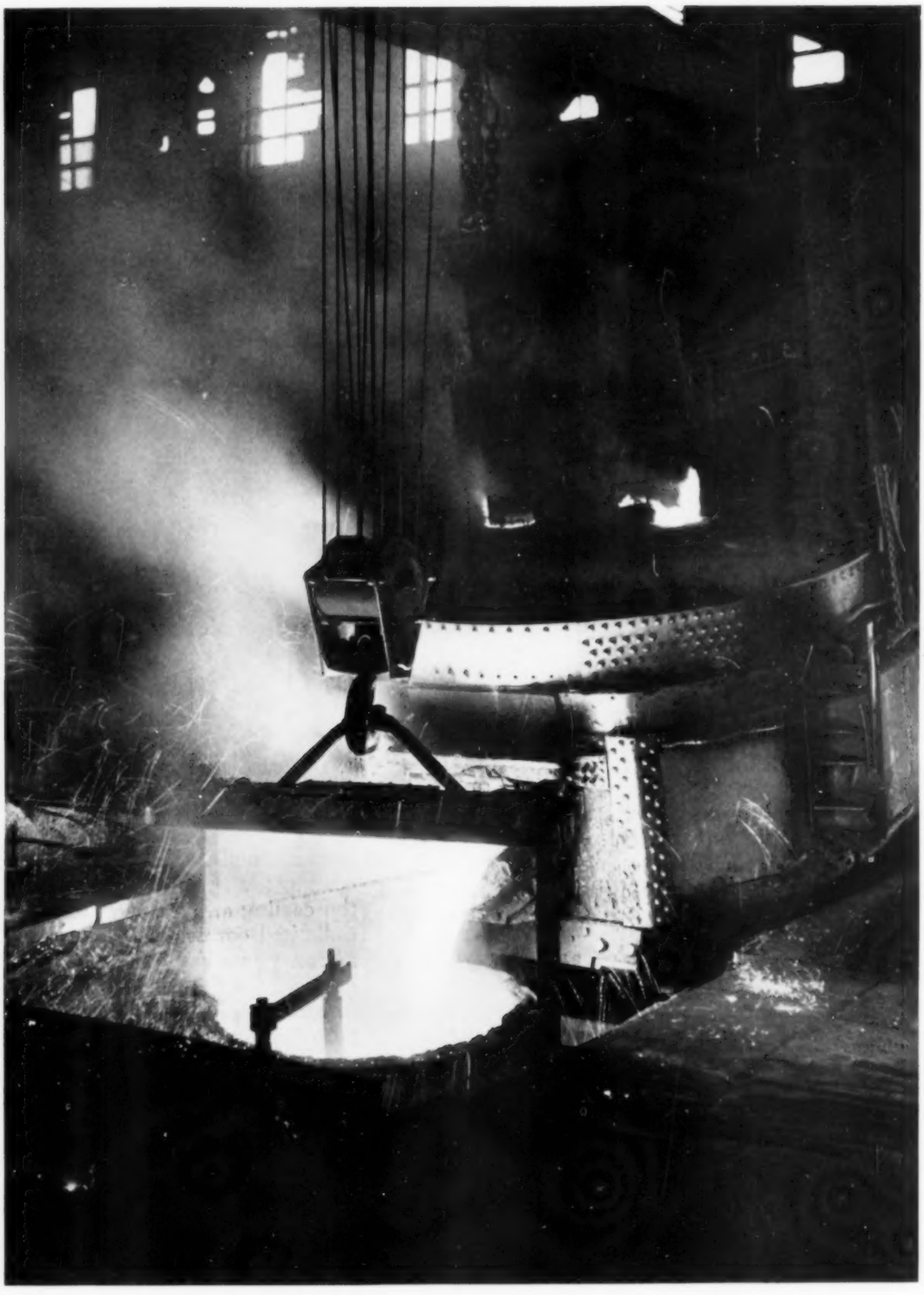


Pouring a Heat at the
Republic Steel Corporation

Resistance Welded Pipe

A much-discussed innovation

By Ernest E. Thum

THE business of pipe manufacturing is in a state of flux.

Thirty years ago the requirements of engineers and builders were met by butt and lap welded pipe, in standard, extra heavy or double extra heavy wall thickness. Large diameter steel pipe — too large to make by lap welding without danger of the white hot tube collapsing of its own weight — were made of riveted or lock joint plates.

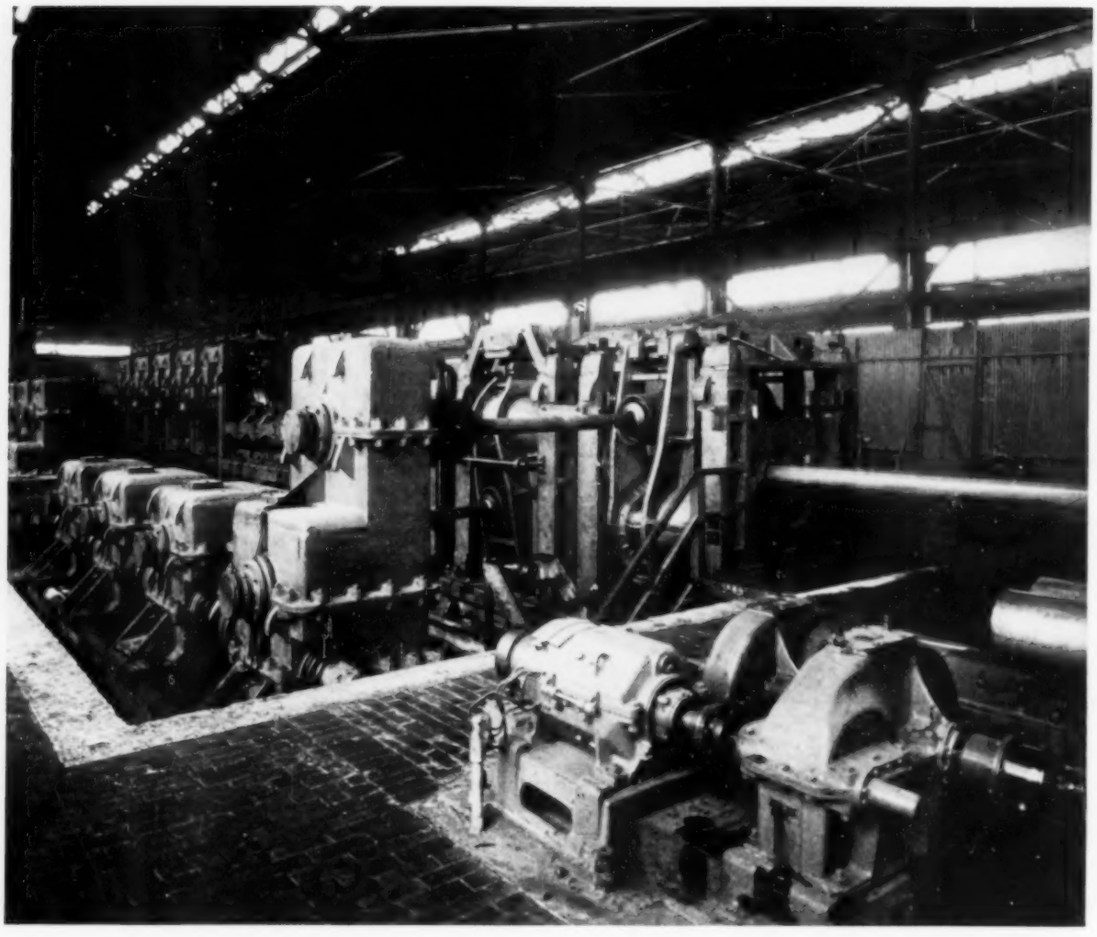
Thin walled mechanical tubing, as exemplified by the bicycle frame, was the first serious innovation. At the start it was relatively costly, for it was cold drawn from a pierced billet. As its uses expanded in more recent years, going into electrical conduit, automobile parts like driving shafts, steering columns and exhaust pipes, metal furniture and ornamental iron work, its cost was lessened by automatic machinery for forming strip into a continuous tube, with longitudinal seam welded on the run by an oxy-acetylene flame, and later by an electric current.

Seamless tubing was also produced to meet the more exacting service of drill pipe in the oil fields and high pressure boilers in power plants. Mannesmann and automatic, or "Stieffel," mills were installed to produce this material at an economical cost, and of chemical analyses desirable for high strength but unweldable by the lap welding furnace methods.

Lap welded pipe had to meet even further competition for oil and gas transportation lines, which have increased so in size and number during the last ten years. Especially the transportation of gas from the newly opened fields in Louisiana and Texas to the centers of consumption in the populous cities and industrial regions in the North Central States, required lines hundreds of miles long, with diameters near the economical limit for lap welding, and operating at such unusually high pressures as 750 lb. per sq. in. The A. O. Smith Corporation grasped this opportunity to produce line pipe made from rather higher carbon steel than formerly used (and thus permitting a thinner wall), starting with a flat plate bent cold, and with longitudinal seam made by metallic arc welding, using an automatic welding head.

Now enters yet another variety of pipe into the field — electric resistance welded. It is a logical expansion of the methods used successfully for nearly ten years in the manufacture of mechanical tubing. The process is covered by American patents issued to Gustav Johnson in 1921, and developed commercially by Steel & Tubes, Inc., in plants in Cleveland, Ferndale and Warren, Ohio.

These plants have manufactured electrical conduit and mechanical tubing in diameters from $\frac{3}{8}$ to $4\frac{1}{4}$ in. and wall thickness from 0.015 in. to 0.156 in. As described in Research Paper



First the Bending Rolls, then the Welding Stand. A flat plate entering at the extreme left is bent into a U in the first set of five roll stands, and the circle is completed in the series in the foreground. Passing directly on through pinch rolls it enters the huge housing containing the welding machine, and then on out through sizing rolls to the straightener.

No. 161 of the United States Bureau of Standards (which contains the results of extensive tests on the product) the method of manufacture is as follows:

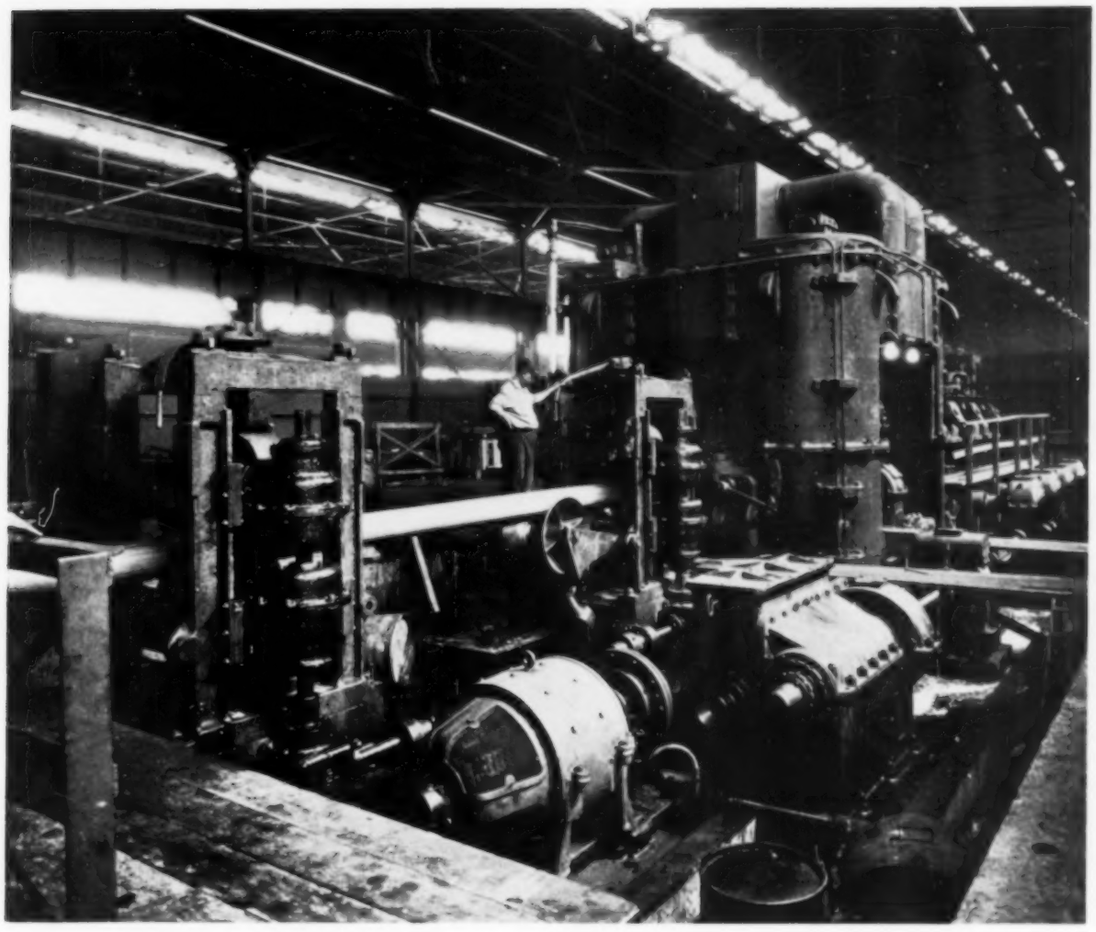
"Strip steel of the required width is passed through a series of rolls to give it the tubular form.

"The edges along the longitudinal seam are accurately butted as the blank is propelled under two electrodes which make continuous contact on both sides of the seam. The electrical resistance of the metal brings the abutting edges to the welding temperature. Forces are immediately applied by mechanical fixtures to complete the weld. The tubing is said to be welded at a speed of about 50 ft. per min."

Development of Resistance Welded Pipe

Much of this material is used in places where considerable internal pressure is imposed, as in pneumatic carrier systems and where drastic cold work and forming is done, as in metallic furniture. Experience indicated that the resistance weld so made had both strength and ductility on the same order as the flat strip from which it was made. Consequently it appeared logical to Republic Steel Corporation, when it acquired Steel & Tubes, Inc., to develop the process to large diameter, thicker walled pipe, such as demanded by the multitudinous uses of building construction, steam power distribution, oil country goods and gas trunk lines.

A small mill was accordingly installed alongside the lap weld mill of the Republic Iron & Steel Co. plant in Youngstown, Ohio, and within the year about 2000 miles of pipe up to 7 in.



diameter has been produced as a commercial operation and sold to various firms in the oil and gas industry, where it has been giving satisfactory service.

Encouraged by the early success of this new method of making standard pipe, Republic Steel Corporation at once started construction of a large plant in Youngstown for its manufacture. This new construction covers an area of five acres, one building, 160 ft. wide by 1100 ft. long housing three mills, one for producing pipe 2 to 7 in. in diameter, one for 8 in. maximum diameter, and the third for pipe 8 to 16 in. in outside diameter.

Plate Edges Accurately Trimmed

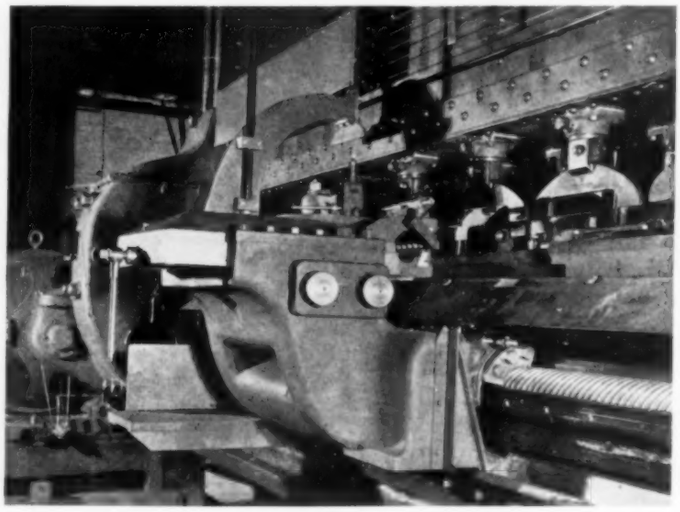
Universal mill plate, rolled from mild open-hearth steel is the raw material of this mill. The plate is ordinarily something over 40 ft. long so that the pipe after cropping and trimming each end, will be as long as can be loaded into gondola railroad cars. (Such "double length" pipe is favored for trunk lines, since the longer the pieces, the fewer the field joints.)

Width of the plate as received is slightly wider than the theoretical circumference of the pipe, and the first operation is to cut the edges back exactly parallel and to exact width. This is done in a pair of slitters of unusual design. Each machine looks like a huge edge planer—a number of pneumatic clamps built into a large plate girder holds the plate firmly down against the bed. This bed has ways along both sides, and two tool holders are simultaneously drawn along corresponding lead screws, one on each side of the bed. In each tool holder is a set of tools, placed close to each other, which not only cut a groove into the plate, thus trimming off the most of the excess metal, but also some other tools set to exact line and position, so that the edge is trimmed exactly square with one passage of the head. All this cutting is done at the rate of 40 ft. per min.

The tool heads, on their return, drag in another plate and push out the completed one ahead of it, both entrance and exit being through arched openings in the end housings.

Continuous Cleaning, Forming and Welding

Next the plate must be effectively de-scaled. This may be done either by pickling or by sand blasting. Equipment for the latter process is installed in the large mill at Youngstown, the plate being passed endwise through a box-like housing, and enroute it receives on both sides the blast from several nozzles. Scale-free metal is the best foundation for the paint or other coatings given to the finished pipe.



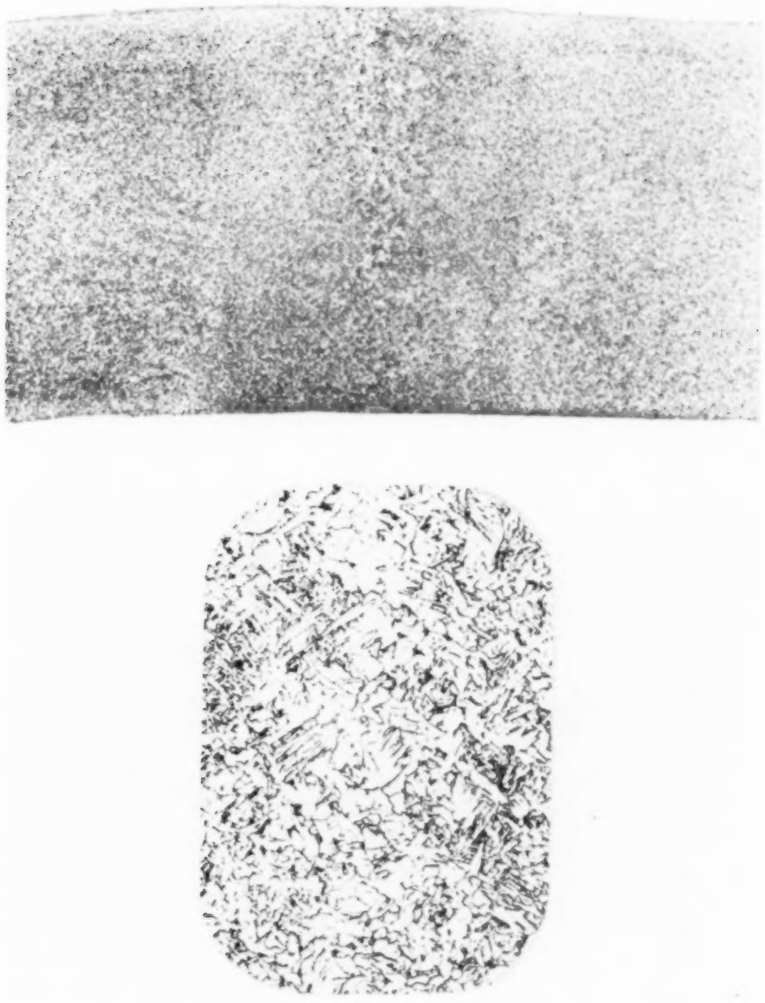
Typical of the Massive Machinery in the Republic Pipe Mill is the Sellers Double Edge Trimmer. One cutting head with its nest of tools is shown at the end of the stroke, against a background of girder, hold-down clamps and bed plates.

With this very small preparation, the plate is ready to make into pipe. It first enters a series of about a dozen rolls, closely set like a continuous mill, which forms the plate into the proper tubular section. Passing on, it immediately enters the welding stand. Pinched from each side by suitable rollers, the seam at the very top is straddled by a pair of hardened copper discs set parallel to each other. These rotate as the pipe passes along, always making good electrical contact with the pipe below, and leading in an alternating current of sufficient voltage and amperage to heat the longitudinal pipe joint almost instantly to the welding temperature. Simultaneously it is squeezed from the sides so that a weld (called a "combination resistance and pressure weld") is formed with a slight upset, both inside and outside. The edges are perfectly clean, however, and no large flash is needed, as is usually required in ordinary butt welding, to eliminate the dirt, scale, and oxide formed in the plastic surfaces of contact. Within two feet of the place where this heat and pressure are produced the pipe enters a series of closely nested sizing rolls, at the same time the welding burr is removed, producing a smooth surface inside and out and of like appearance to the remainder of the tube.

This method of slow forming leaves the ductile open-hearth plate ordinarily used without an undue or harmful amount of internal stress. The welding heat is injected into a narrow strip along each side of the joint. At the very edge the temperature is very high—at a welding heat, of course—but the grain growth occurring is broken up by the direct squeeze between internal and external rolls immediately following the welding.

The net result is a refined grain in the metal at and adjacent to the weld, as shown in the accompanying macrograph. Numerous tests to destruction by over pressure, both of mechanical tubing and line pipe made by resistance welding, show that the pieces under test split longitudinally at some distance from the weld, in the metal well beyond the locally heated zone. This strength is not gained at the expense of ductility, for the pipe withstands flanging and upsetting so well that it is a favored material for using with the familiar Van Stone joints.

Normalizing furnaces are installed for heat treating high carbon open-hearth pipe and low



Macrograph of Pipe Fragment, Cut Squarely Across Weld, Shows Little Recrystallization, Micro at 100 diameters was taken at center of joint. Pipe was 6⅝ in. outside diameter, ¼ in. wall.

carbon Bessemer pipe. These classes are apparently quite sensitive to the effects of cold work. However, mild open-hearth steel pipe is sent immediately after welding to a husky set of roller straighteners.

Inspection and Proof Tests on Each Length

After straightening, each end is inspected. The next operation is in equipment for cutting pipe to lengths required for the particular order in production as well as for cutting crops for tests. Before the pipe leaves this station, however, each crop end is placed under a small hydraulic press, placed close by, and, with line of weld where it takes the sharpest bend, is flattened down under the rapid travel of the platin. If the weld shows any fracture before reaching one-third its diameter under this test, the pipe is cut back to sound metal before going further.

Final machine work consists of threading the ends or beveling them for welding. This is done with a pair of powerful cutters, each machine built into a carriage capable of traveling toward the other in long ways. By this means the machines are adjustable to the length of the pipe, and both ends are cut simultaneously.

Before painting and loading, each pipe is given a hydraulic test. After being filled with water, the required test pressure is held the desired time and an inspector walks the full length of the pipe looking for defects or signs of over stress. On his signal the internal pressure is relieved, and the pipe rolled out to the painting bay. All this cycle is recorded on a time chart, which is then a part of the permanent files indicating the test on each pipe of a given lot.

On visual inspection, the shining, sand blasted surface gives the pipe an excellent appearance. To find the weld frequently requires close inspection. Inside, the pipe is nearly as smooth as outside, any slight upsetting occurring during the weld being nearly ironed out in the subsequent rolling. Owing to its method of manufacture, the thickness of wall is quite constant, point to point, this being governed by the precision of the plate mill. In this respect the pipe is much more uniform than commercial seamless pipe, which is difficult to produce with close limits of wall thickness. Threading shows no trace of the weld — the chips are continuous.

Centrifugal Castings

Make Excellent Artillery

CENTRIFUGAL castings for large guns have both metallurgical and economic advantages over gun forgings. Col. Tracy C. Dickson, commanding officer of the Watertown Arsenal, Watertown, Mass., will explain these advantages in a paper which he will present before the National Metal Congress in Chicago, entitled "Casting Guns by the Centrifugal Process".

From a metallurgist's viewpoint, centrifugal castings have the following advantages: Carbon segregates toward the gun bore, making the steel's proportional limit greatest where the stresses, caused by powder pressure, are maximum; the tensile and Charpy properties of the completed gun are higher; the metal of the bore is under compression, which Colonel Dickson believes may be the reason why a centrifugally cast gun barrel requires a higher interior pressure than a forging of similar size to stress the metal at the bore to its proportional limit.

Centrifugally cast steel is, moreover, slightly denser, showing that gases, slag and

non-metallic inclusions are forced by the centrifugal action into the bore or into the metal adjacent to the bore which is later removed by machining. Another advantage is the absence of the pipe and shrinkage cavities inherent in ingots. Centrifugal castings can also be expanded by cold work (a standardized practice at the Arsenal) to twice the percentage of enlargement of the bore diameter practical with forgings, and consequently the weight of a centrifugally cast gun can be reduced while the strength of a forging is still retained.

A cost accountant's comparison of a centrifugal casting with a forged gun would show, according to the author, the following economies of the former: It is not necessary to discard at least 35 per cent of the weight of each ingot used; heating and forging operations are eliminated; less than half the quantity of raw materials are required to make the same number of guns; less plant equipment is needed even to maintain war-time production; time of production per gun is greatly shortened; and, in general, cost of manufacture is reduced.

Centrifugally cast guns are produced in the comparatively simple machine shown in the illustration. A revolving, thin walled steel cylinder contains a cast iron chill mold into which the metal is poured from the stationary pouring box shown at the right side of the machine, through an appropriate spout. Both ends of the mold are closed with plates with central openings, one for admitting the metal and the other, at the motor end of the mold, for allowing air and gases to escape. The rotating member rests on two pair of rollers, and is held steady by one in each top housing shown in the illustration. Each roller is in turn supported by roller bearings.

To make the casting, a steel with 0.35 to 0.45 per cent carbon, 0.60 to 0.70 manganese, 0.30 molybdenum, and 0.05 vanadium, is melted in a high frequency induction crucible furnace, which can be picked up and poured directly into the box at the end of the casting machine. Pouring temperature is the lowest which will permit the last of the metal to enter the mold with sufficient fluidity.

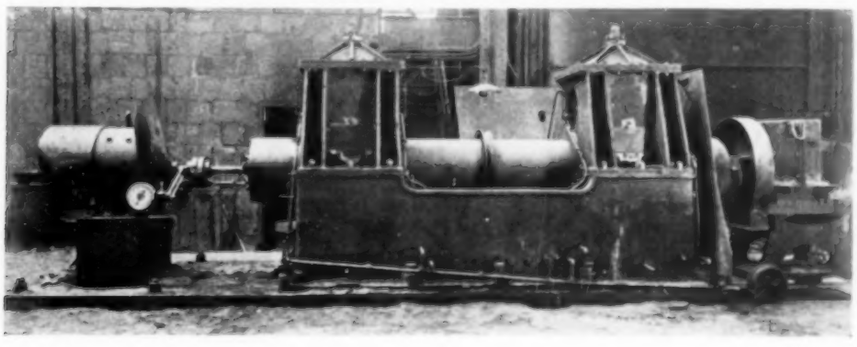
The mold is brought to the desired rotating speed before pouring begins. The speed of pouring and of rotation may be kept constant during solidification, or they may be reduced gradually as the steel enters the mold. A reduced rate of pouring is favored in the casting of thick walled guns.

The contraction in volume produced by successive solidifications tends to decrease the diameters of the inner layers of metal which are at the same time being forced outward by centrifugal force. This action eliminates shrinkage cavities and makes the casting more dense than a forging of similar composition.

Physical properties of tangential specimens quoted in Colonel Dickson's paper are on the following order:

Tensile Properties	Heat Treated Casting Before Expanding	Cast Gun After Expanding 40 per cent	Cast Gun After Expanding to Rupture
Ultimate strength	90,000	114,000	120,000
Proportional limit	63,000	103,000	105,000
Elongation in 2 in.	27	—	—
Reduction in area	65	50	54
Charpy impact	40	27	—

Equipment For Casting Gun Tubes Is Relatively Simple. Motor at left rotates the cylinder within roller bearings held in massive housing. Cylinder itself contains chill mold of desired internal shape, and this mold is slowly filled from pouring box at extreme right.



by L. W. Spring

Progress in Metals

Requirements of Steam Generation, Petroleum Refining and Chemical Industry To Be Met

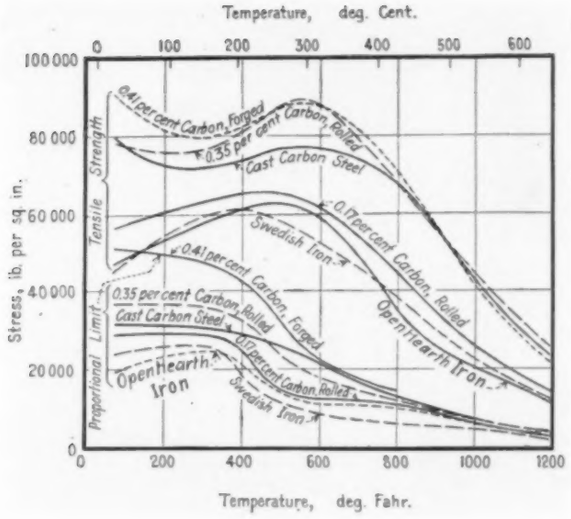
Pipe, Headers, Valves, Bolts, All Require Special Study To Make Sure of Long Life When Conveying and Controlling Steam.

THINGS are not what they used to be. Somewhere about 1780, Watt, who had invented the steam engine, was upbraided for carrying the tremendous pressure of seven pounds of steam in the boiler! It was held to be a menace to the neighborhood since the boiler might burst and kill people.

Stephenson, with his first steam locomotive, the Rocket, proposed to transport passengers at the terrific speed of twelve miles an hour! This was considered a serious matter by some, since such speeds could hardly be conducive to human health and safety.

What would those objectors think of the steam pressures of 1500 lb. per sq. in. now being used and of the 250-mile speeds of our airplanes and racing cars?

How has all this progress, as we recognize it now, come about? Not by dreaming, though the dreamers may have given the more practical steel worker, engineer, chemist and metallurgist some intimation of what was desirable. This progress has come about through "close to the ground" fighting every step of the way to improve, little by little, on what had been developed previous to that moment.



When Rapidly Tested at High Temperatures, Common Steels Are Strongest At About 550 Deg. Fahr., Although The Proportional Limit Is Seriously Reduced at Heats Above 400 Deg.

It was not so long ago, for some men now alive remember it, when wrought iron rails were used on the few railroad lines which this country boasted. The substitution of the better, larger and harder Bessemer steel rail followed and the latter was succeeded in turn by the still better open-hearth steel rail, development always proceeding to stronger and heavier sections until now 130 lb. rails of 0.60 to 0.80% carbon steel are commonly laid on main lines.

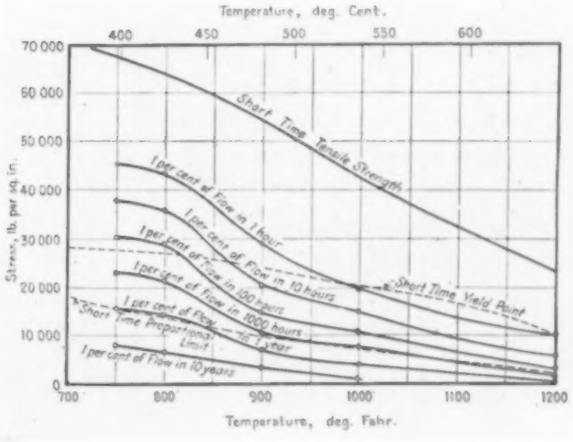
High Pressure Steam Generates Most of the Power

An important part of our present civilization depends upon what we may term the high temperature-high pressure industries, particularly those concerned with the generation and use of steam power, the distillation and cracking of petroleum, and certain of our chemical industries.

It is not generally known how great a part superheated steam plays in our commercial life today, its development having been so steady and so quiet. If the power stations in our cities should take a day off, most of our factories would stop, our elevated train service would cease, our electric lights would go out, and our refrigerators would cease to function. Except in localities where abundant water power is available, steam-generated electricity is doing this work of the world. Everyone realizes what the stopping of our gasoline driven automobiles, motor buses and delivery trucks would mean; the high temperature chemical industry is not so close to our immediate well being, of course, but high temperature steam is the back bone of industrial civilization in America.

A Thirty-Year Development

About the first of the present century, steam pressures had risen to 150 to 200-lb. gage pressure. In the old style boiler, the steam remained in contact with the water from which it



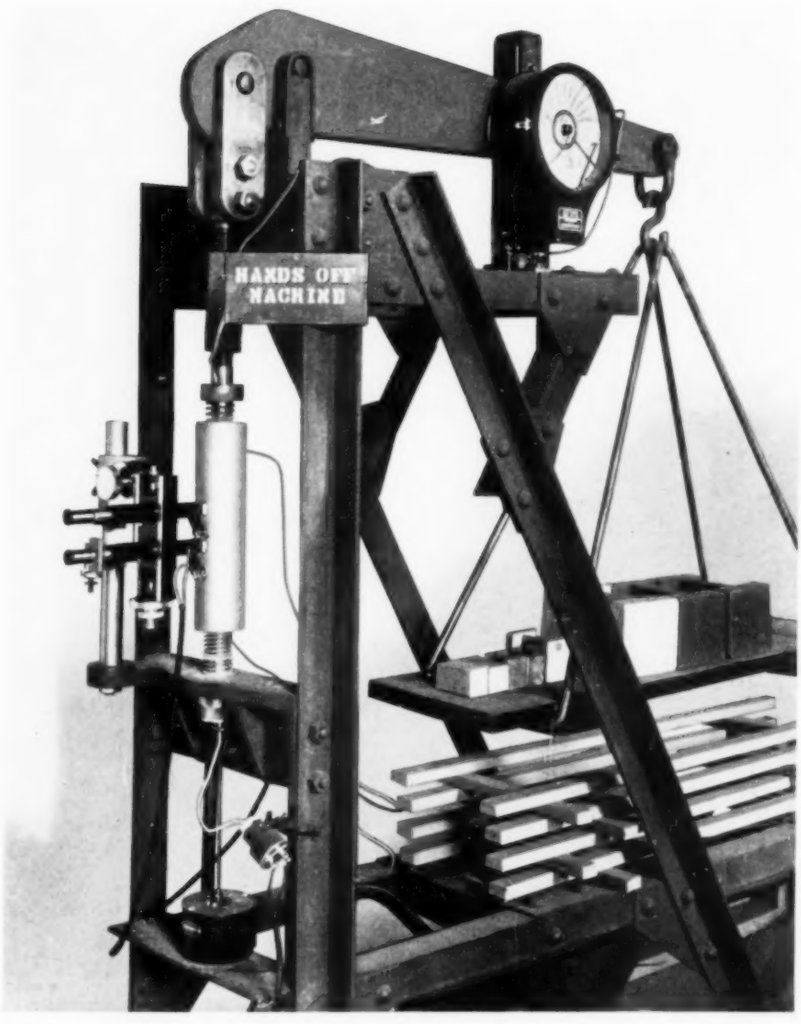
If a Mechanism Would Jam and Have to Be Replaced When It Enlarges One Per Cent in Size, It Would Last Only One Year If Made of Cast Steel and Operating at 850 Deg. Fahr. and 10,000 Pounds per Square Inch.

boiled, and therefore it was "saturated" steam —that is, the steam contained a certain amount of moisture which it carried on to the engine. The temperature of such steam always has a definite relation to the pressure in the boiler.

To achieve greater efficiency and power in central stations, superheated steam came into general use about 30 years ago. Superheated steam is steam which has been conducted away from the water in the boiler and further heated in another vessel or system of pipes, called the "superheater", thus being made into a "dry gas." Early superheating brought the total temperature from 388 deg. Fahr., the maximum for

saturated steam at 200 lb. pressure to 550 or 600 deg. Fahr., according to the amount of extra heat put into it.

Ordinary lap-welded steel pipe and cast iron valves and fittings had been quite serviceable and satisfactory when used with saturated steam, but with the higher temperatures these materials were found to be hardly adequate. Occasionally a piece of the cast iron equipment cracked or changed in size or shape somewhat, so that soon the much stronger and much more ductile cast steel was found to be necessary for the fittings. The keen competition and the constant desire to chase downward the cost of the kilowatt of electricity, gradually brought about higher and still higher steam temperatures, and for the past five or ten years steam at 650 to 750 deg. Fahr. has been used. While this top limit of 750 deg. Fahr. was definitely understood to be the maximum for temperature, the pressures used with it gradually rose as new and more modern steam generating stations were built. During the past three to five years 1500 lb. per sq. in. has been the operating pressure in at least half a dozen power stations in this country.



By Lever Action a Constant Load is Placed On a Test Specimen, Which Is Then Surrounded By an Electric Furnace and Temperature Maintained Rigidly Constant. Slight stretching of the hot metal is observed by the two telescopes, through slots in the furnace wall.

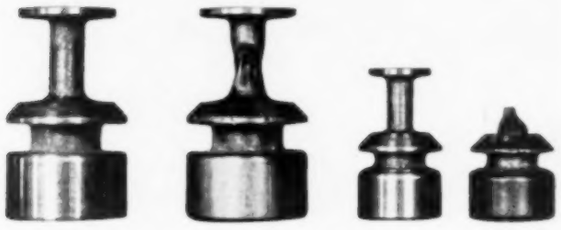
Temperature Limited to 750 Deg.

But why 750 deg. Fahr. maximum temperature? As far back as the year 1820 it was reported that at red heat wrought iron retained only about one-sixth of the strength which it had at ordinary temperatures. In 1837 a commission from Franklin Institute studied the cause of boiler explosions and reported in Dingler's Polytechnic Journal a series of physical tests made on copper, wrought iron, steel and brass at various temperatures from normal (70 deg. Fahr.) to red heat (about 1400 deg. Fahr.).

More and more tests of the strengths of metals at various temperatures were made as years went on, and these materials were more and more needed. The literature of the last 50 years is replete with information on the characteristics of various metals under the effects of temperature and stress. Authors of many of these include the names of illustrious men in the testing and engineering fields. The curve sheet shown in this article indicates how the common metallic materials of construction have a maximum strength when tested quickly at

temperatures between 500 and 600 deg. Fahr., whereas at 750 deg. a serious weakening has occurred. From such tests have arisen the common limitation of 750 deg. Fahr. for high temperature work.

The past decade especially has seen not only a relatively greater amount of work done but the tests made have been more definitely applicable to practice and design. The form of testing also has changed materially to give greater meaning to the results of such tests. Instead of the so-called short-time tests, in which a specimen is heated for an hour or so to the temperature desired, *without* load or stress, and then quickly and carefully broken while hot in the testing machine, we now have results from the more modern and more applicable method of "long-time", "flow", or "creep" test, in which specimens are held at desired temperatures in a testing machine for days, weeks or months, constantly under a definite test stress, the length of the specimen being read daily with very accurate measuring apparatus.



If a Little Steam Leaks Past a Check Valve Disk, It Cuts Away at the Stem Until It Is Clear Gone.

Despite the reticence of designers of boilers, pipe lines and valves to use temperatures above 750 deg. Fahr., although such would give greater yield of kilowatts per pound of coal burned in the firebox, the oil refiner had been deluged with orders for oil and gas for automobiles, airplanes and furnaces. Whereas upon ordinary distillation, crude oil yielded only about 25 per cent of its volume of gasoline, the chemist had learned that the yield of this more valuable fluid could be greatly increased, even up to 50 or 75 per cent, by breaking down the heavier oils or fractions by heating them under suitable conditions to temperatures of 900 deg. Fahr. or even higher. With the enthusiasm of the pioneer, and driven by opportunity for financial return, the oil refiner cut his factor of safety in half and often to a quarter of what formerly had been demanded, constructed the necessary equipment, and went ahead with his new process refining.

Periodic Inspection Reveals Dangerously Overstrained Equipment

Fortunately his campaign, or time required for the "batch" run, was only about a week long, as against the months or years run continuously by the steam station without shut-down. The oil refiner therefore had a chance to examine and to replace if necessary injured or dangerously weakened equipment, which the steam station men do not have, the latters' customers demanding constant day and night service.

After marking time at 750 deg. Fahr. since 1925 because of the necessity for continuity of operation and safety, and because of the much higher cost of special equipment, the steam plant designer is now determined to go ahead. Already he has designed stations for operating at 850 deg. Fahr. total steam temperature and he definitely asks metallurgists and steel makers for materials to stand service for 10 to 20 years at temperatures up to 1000 deg. Fahr., which is a low red heat in a dimly lighted room.

Tests at the laboratories of Crane Co. show that at 1000 deg. Fahr. steel has only approximately two-fifths of its strength at normal temperatures. Consequently the 3500-lb. pressure requirements now being sought mean thicker walls in boilers, pipe lines, and valves, irrespective of the temperature effect. This, with the addition in thickness to make up for loss in strength due to the high temperature used, often results in valves so bulky and with flanges so thick (if built of carbon steel) that there is difficulty in getting room for the nuts on the bolts which join them. For such reasons a stronger steel or one which loses less of its strength is badly needed.

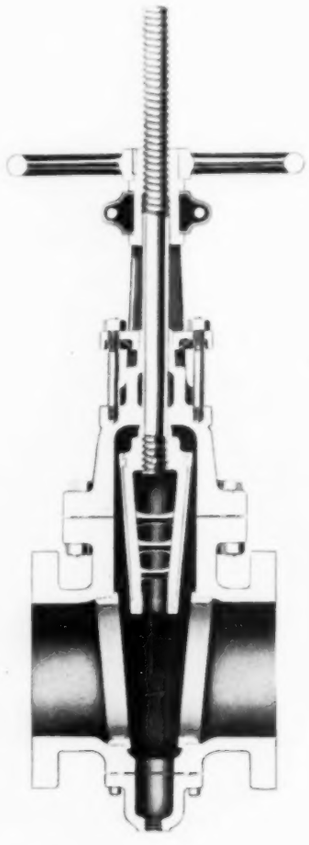
Once upon a time, first cost of equipment was a big factor. Now, high first cost is no bar to the constructor, providing the life and service given will be such as will give an eventual profit on the investment. For this reason

new alloys with valuable properties will have a chance, even though they are expensive to cast and work.

Possibilities of Strong Alloy Steels

Steels containing small amounts of nickel and chromium, such as the S.A.E. 3100 and 3200 series, the S.A.E. 6100 chrome-vanadium, the medium manganese steels, and the well known high chromium stainless steels, have been studied and even put in service, but all were found to suffer much the same loss in strength at high temperature as do the ordinary carbon steels. Now the austenitic steels are being tested, such as the 18 per cent chromium, 8 per cent nickel with or without silicon, molybdenum, and tungsten; the 8 to 10 per cent chromium, 17 per cent nickel steel; the 35 per cent nickel, 20 per cent chromium; and a number of others.

While the austenitic steels lose proportionately less strength at the higher temperatures than the pearlitic varieties, the question of chemical stability yet remains to be settled. With some, there is apparently a tendency to precipitate carbides upon long heating, and this perhaps will result in brittleness — a quality which every engineer greatly fears. The austenitic steels have the further disadvantage of extreme toughness, which makes their rolling, piercing, and drawing into shape, cutting with tools, and other fabrication operations extremely slow and expensive. They have, of course, the great advantage that they do not rust as does ordinary steel, but this factor is comparatively a less important one for high temperature service, at least as far as steam service is concerned.



Modern Gate Valve for High Temperature-Pressure Service Requires Selected Materials For All Parts.

Valve Requirements Particularly Severe

But the whole subject cannot be spoken of in such general terms.

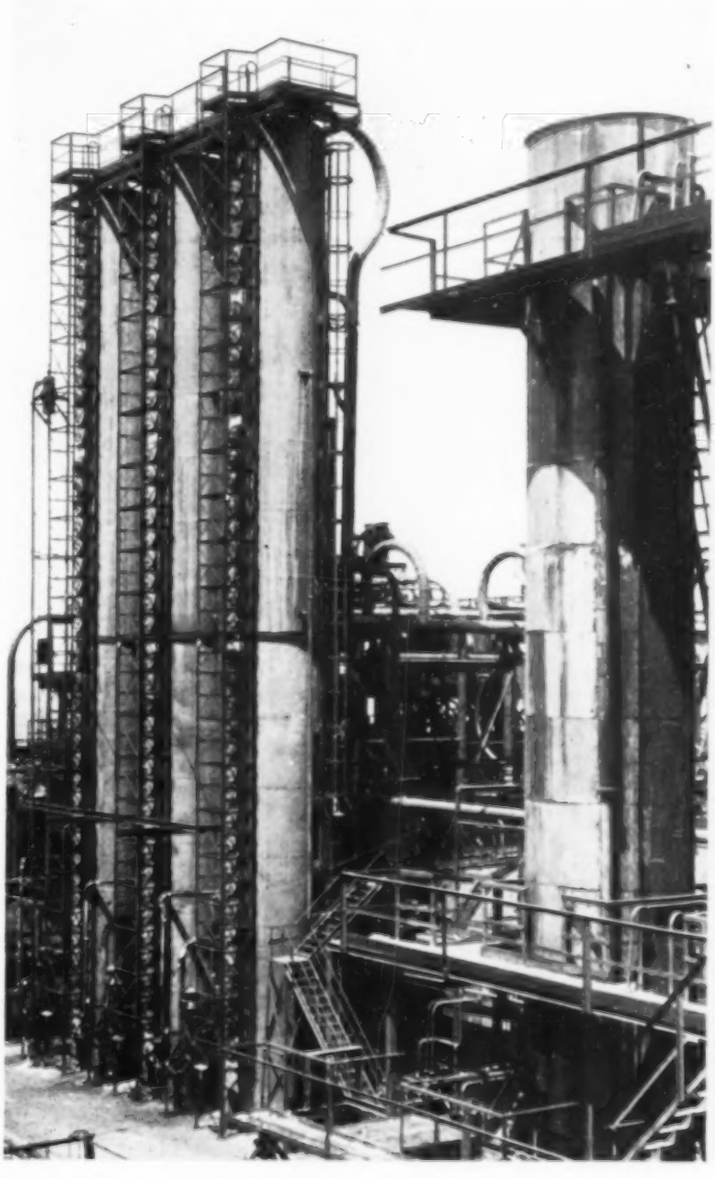
Consider a valve. It is a comparatively complex operating mechanism designed to stop the flow of steam or other fluid at will, or to allow it to proceed. One style, the gate valve, does this by means of a wedge or gate which can be forced down across the opening through the valve, called the run, or withdrawn by means of the hand wheel, or, in large valves, a motor controlled gear wheel on the top of the stem.

Closure must be perfect if steam, gas or other fluid is to be prevented from passing through the valve. The seats not only must be well designed and manufactured to close tightly against each other, but they must be made of materials which do not rust or corrode and which do not become scratched when a piece of pipe scale or dirt lodges between them as they are closing. Some metals, too, actually seize or abrade each other when their surfaces rub. It has been figured that while being closed against 900-lb. pressure, the gate or disc of a 16-in. gate valve exerts a seat-to-seat pressure of around 5000 lb. per sq. in. It will be realized that a slight scratch or imperfection, whereby a trickle of steam or other fluid at such high pressures can start to leak through, will rapidly be scoured into a larger passage, resulting shortly in an impinging stream of fluid coming through and doing serious damage where it strikes. Sometimes a hole is cut entirely through the wall of the valve where such a stream is deflected. A seat-leaking valve is not serving its function in

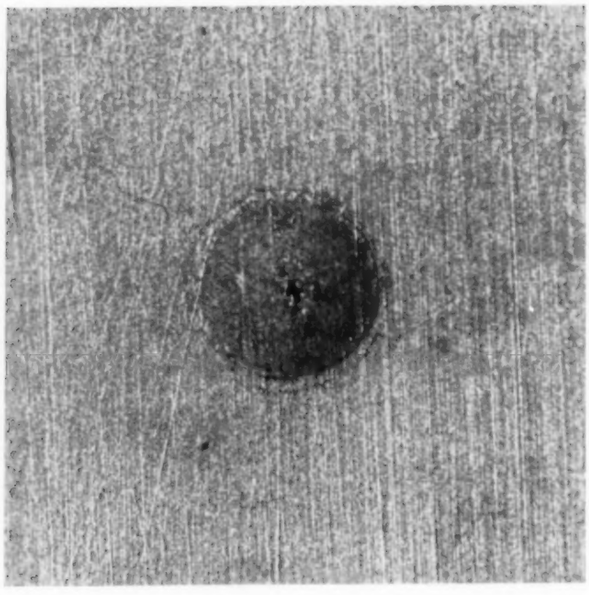
the first place, and the necessary removal of the valve shortly afterward due to non-tightness and sometimes to a cut through the wall, interrupts the pipe line service seriously and cannot be countenanced.

Metal for valve seats and its accurate manufacture and fit in the valve, is therefore a most important matter since the tightness of seat may be considered to be the life of the valve. First of all, seat metals must be non-corrosive, and resist rust. Brass, Monel metal, nickel, nickel alloys, stainless steels, and some harder alloys are used, depending upon the service desired. The corrosion resistance spoken of before, the hardness, coefficient of expansion and several other qualities must be taken into consideration in selecting metal for valve seats.

The oil refiner has much the same problems, and he already knows as much as he cares to know about wire drawn valves and scored seats. While he shuts his stills down every week or so, and therefore has opportunity to examine and to replace seriously damaged parts, he has the added disadvantage of handling a quite corrosive product. Most of his crude oils carry corrosive sulphur compounds; the oil wells also yield salt water which gives slight amounts of hydrochloric acid during the distillation process. These, with other corrosive media, remove a considerable amount of the metal from the inner walls of the equipment of the stills, pipe lines, valves and tanks, so the oil refiner expects a relatively shorter life of his equipment in service through this serious matter of chemical corrosion. He operates his stills at temperatures ranging from 900 to 1100 deg. Fahr. or even higher, and his pressures are from 600 to 1400 lb. per sq. in. Even more is required in some processes. So the designing engineer, the metallurgist and the steel maker will not be out of a job for some time yet. With the steam engineer clamoring for new metals to withstand the heavy service of 1000 deg. Fahr. and 3500-lb. steam; the oil refiner asking for equipment for 900 deg. Fahr. and 1400 to 3000-lb. pressure to withstand the extremely corrosive crudes from the Panhandle in Texas, and some chemical manufacturers now using reactions at 1100 deg. Fahr., (even though the chemical industry in this country is virtually just beginning,) there is plenty of reason for members of the American Society for Steel Treating to feel that even yet we are but pioneers in this matter of metals.



Oil stills and towers recently constructed at the refinery of the Associated Oil Co., Martinez, Cal. Metallurgy's part in the construction of this equipment includes supplying drums, pipes, plates, valves and fittings of many steels, some corrosion resisting and others of great tensile strength. The stills appear in the background behind the three towers. This photograph is reproduced through the courtesy of the Associated Oil Co. and the National Petroleum News.



Rapid Estimation of

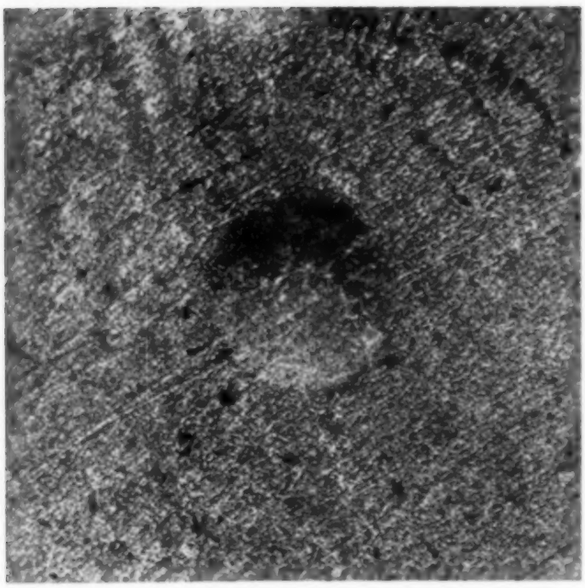
NITRIDING, being an essentially new method of creating an excessively hard yet very thin case upon alloy steel parts, has brought with it many problems. Among those causing general discussion are the proper method of judging the hardness and brittleness of the extreme surface, and of estimating the depth of penetration.

Scratch hardness, such as employed in the device called the micro-character, can give an accurate measure of the hardness and depth of a nitrided case but this method is time-consuming. A. B. Kinzel and John J. Egan, metallurgists in the Union Carbide and Carbon Research Laboratories, have found the diamond ball penetrator useful, as exemplified in the monotron, when proper choice of penetration depth and load was made. Comparison of spots on a single specimen, or a number of specimens in which the hardness-depth characteristics are similar, can be made with sufficient sensitivity by using a Rockwell hardness tester with a 1/16 in. ball and a 100 kg. load, if a new standardized ball is used for each reading.

Ductility of the nitrided case is also estimated by these investigators by noting the type of failure produced with a 10-mm. Brinell ball under variable loads. The macrographs shown on these pages are typical brittle and ductile cases. Cracking around the edge of the impression, and in the center indicates a comparatively brittle condition, while absence of such cracks is a positive indication that the case will not spall readily.

Depth of case can be measured with the microscope much more easily than by taper grinding and testing the hardness of the conical surface. Likewise it is adaptable to parts of any size and shape. A reagent has been developed by J. Vilella of the same laboratories which not only reveals the structure of the case, but also etches the material so that a line of demarcation corresponds to a definite and appreciable change in hardness.

Correlation between case depth and etching effect is clearly shown in Fig. 3, in which a micro-character scratch is shown on an etched surface. The distinct and sudden change in

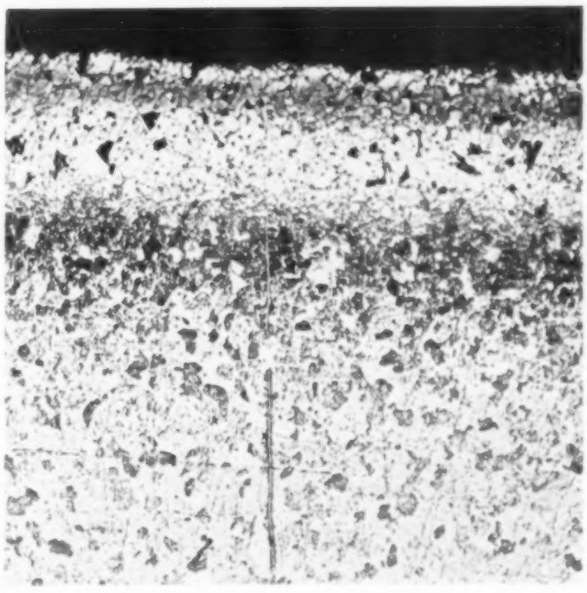


Appearance of Brinell impression on Brittle (left) and on Ductile Case. Magnification 15X. Load 500 kg.

Nitrided Case

width of the scratch at the edge of the etched band is illustrative of the action.

The etching solution is made by dissolving in 100 milliliters of water the following reagents: 1.25 g. copper sulphate, 2.5 g. cupric chloride, 10 g. magnesium chloride, 2 milliliters concentrated hydrochloric acid, and diluting to 1000 milliliters with 95 per cent ethyl alcohol. Ingredients should be carefully weighed and measured, as inaccuracies result in marked differences in the etching properties of the solution. Excessive copper sulphate diminishes color contrast, while increased cupric or magnesium chloride retard the copper deposition and impair the reagent's sensitivity. Immerse the specimen 10 sec. in the reagent, polished surface down. Dropping the reagent on the surface results in very confusing edge effects. The quality of the etch can often be improved by repeated polishing and etching. The etched sample can be placed on the stage of a photographic microscope, with lenses and bellows extension set for 100 magnifications, and the depth of case measured directly with a rule.



Cross Section through Nitrided Chromium-Aluminum Steel, Polished and Etched with Vilella's Reagent. Microcharacter scratch suddenly widens when free of etched band, into softer backing. Magnification 100X.

Recently Discovered Facts About Corrosion

By F. N. Speller

A REVIEW of the developments resulting from recent investigations on corrosion should be valuable not only to emphasize the practical lessons that have been learned, but to note how far experience has changed earlier conceptions of the mechanics of corrosion and the relative importance of controlling factors.

The subject is still recognized as one of great importance. In fact, the solution of the corrosion problem often means the difference between profit and loss in operation.

American oil and gas industries, especially, are alive to the situation. During the past two years they have lent considerable support to cooperative work, and the larger companies have employed many technical men to work on this problem. There are now in use in the United States about 100,000 miles of oil mains and 80,000 miles of gas mains. Several more long lines of 20 to 26 in. diameter pipe are projected and contracted for, including lines to carry natural gas from Texas to Chicago and from lower California to the State of Washing-

ton. As thin-walled steel pipe now seems to be favored for economy, the question of protection from soil corrosion is becoming more important. There seems to be a tendency to go to extremes in cutting down wall thickness of pipe. All the more reason why the great investment represented by these underground trunk lines should be safeguarded from rapid extinction from corrosion — it is a vital matter to pipe line owners.

Surface Film of Prime Importance

Many corrosion problems resolve into a question of the stability or instability of the film which separates the metal from its surroundings. While it is important to consider the initial chemical reactions and the mechanism of corrosion, the tenacity, continuity and other physical conditions of the final corrosion product have often much more to do with the utlimate life of the metal. Both the metal and the corroding solution have an important influence in the building up and maintenance of these all-important surface films, and this has been the direction of much of the most recent investigation.

What influence has the metal itself on corrosion and upon the properties of the corrosion product? How much has the chemical affinity between the corroding media and the metal to do with it?

Adhesion between the crystalline aggregates determines physical properties, while the bond between the atoms which make up the crystallites and the atomic structure have more to do with the chemical stability. For the latter reason, constituents of metallic alloys in solid solution have a great influence on resistance to chemical attack. Any separation or precipitation of such constituents in the microstructure of the metal usually weakens this resistance to chemical attack, and should be avoided in manufacture and heat treatment — although it is not safe to dogmatize even here, for in some cases the difference in rate of attack helps to bind a protective film more firmly to the metal surface. In other cases, constituents precipitated at the grain boundaries result in selective chemical attack, and develop local planes of weakness. We may term these films which build up by chemical reaction between metal and its surroundings, "natural" protective coatings, to distinguish them from the many artificially-applied coatings, such as galvanizing and paint mixtures.

Growth of a natural film in any environment is mainly promoted in two ways: by choosing the right metal or metallic coating; or by changing the nature of the environment so as to produce by chemical reaction with the metal a more insoluble and more durable coating.

The first principle is now well understood

and is exemplified in the way aluminum and high-chromium iron ordinarily protect themselves. Chromium is not a noble metal like gold or platinum; in fact it is reported to be more soluble in hydrochloric acid than pure iron. Nevertheless, it has remarkable ability to protect itself by building up a durable film in the presence of oxygen. In stainless irons and steels it is well known that a considerable amount

of chromium is necessary, about 1 part to 10 parts of iron. It often happens that a natural protective coating formed from a more complex alloy is more resistant than from a simple one; the 18-8 nickel chromium alloy, for example, when exposed in water or air is better than the 18 per cent chromium-iron alloy; silicon or aluminum will often add further resistance to such alloys, especially in respect to high temperature oxidation.

Steel having little power of self protection is frequently coated with other metals, like zinc, tin, aluminum, chromium, nickel and copper, which are capable of building up natural protective coatings. Such metallic coatings, while usually porous, may assist in bringing about the formation of a more stable coating if the base metal contains elements which will react to build up a more continuous insoluble coating. For instance, galvanized steel carrying a small amount of copper has been found to be much more durable in salt water than ordinary galvanized steel, probably due to the precipitation of copper by the zinc after corrosion of the steel has started at breaks in the zinc alloy. A small amount of copper (0.3 per cent), however, has very little influence on the life of the base metal when immersed in fresh or salt water or underground.

Another method of building a protective natural film consists in making a small change in the corroding medium, especially when the latter is a liquid. Such a corroding medium may be rendered much less obnoxious by adding to it a relatively small amount of a suitable reacting material. The method is illustrated by the use of alkalies, chromates and other so-called "passivifiers" which render the metal inactive toward the solution by interposing an inert film between the two. Films produced in this way are easily destroyed by excessive heat, or by abrasion, or by chemical action when the film-building material is removed or is not present in sufficient concentration to repair breaks in the film immediately. In closed sys-

tems, (that is, where the circulating medium is used over and over again) this principle of protection is sometimes more economical than to use a more expensive metal for the container. For example: chromates may be used to advantage in refrigerating brines and in circulating water-cooling systems.

Protection Afforded By Rust

Iron rust is one of the most insoluble materials in ordinary water. Once formed it should remain (unless scoured off), and thus it has one of the characteristics of a natural protective film. However, it is usually porous and irregularly distributed and therefore often tends

to promote pitting in the metal. A stronger and denser coating is formed in water pipe when calcium carbonate, silicate, or some other insoluble compounds are precipitated with the rust. This principle is sometimes employed in water works by adding a small amount of lime to domestic water, which carries sufficient excess of the bicarbonate to precipitate some calcium carbonate after the equilibrium is destroyed. Sodium silicate may be used in the same way to protect iron and lead. The City of New York has done considerable work during the past year in an endeavor to find a system of water treatment that will protect iron and steel pipe in this way.

Iron rust also assists in the protection of cement linings and will make them much more durable than they would otherwise be. Such linings have been used for sixty years or more in New England water pipe and are very durable in pipe lines carrying mine waste, in hot water tanks and in other applications where the solution of the cement is retarded by the precipitation of less soluble compounds.

Not much that is new has been developed in protective metallic coatings during the past year. The porosity of both metallic and nonmetallic coatings in thin layers is a condition that should be taken into consideration and remedied. It is sometimes possible to cause the pores of a metal coating to be filled with insoluble corrosion products; as in the case of zinc applied on copper steel. Of course, this is governed largely by the corroding media.

At present it is a question whether rust-resisting metals or metallic coatings will be most economical for certain purposes. The former seem to be increasing in favor at present. Experience and economic considerations will determine the answer.

Corrosion of metals under paint may produce caustic conditions which soften and peel the coating. Corrosion of the metal, therefore, has an influence on the durability of paints and coatings, and there is good reason for using inhibitors in a priming coat where the water circulation is limited and differences of potential exist, as in soil corrosion.

Portland cement mixtures for protection of steel in contact with water and soil have apparently not received the attention they deserve. They have proved very efficient for protecting pipe lines in corrosive soils which attack metal but do not attack cement, and for lining water containers and chemical apparatus. To give best results, the cement mixture should be steam cured for 48 hours after being applied. Ordinary Portland cement linings in water pipe cause the water to become rather hard for a few months, but this may be reduced to a minimum by charging the water during the early use of the pipe with an excess of carbon dioxide to change the free calcium hydroxide in the cement to the more insoluble calcium carbonate. None of the coating materials entirely prevent contact between the corroding media and the metal, but this is not always necessary if the reactions can be materially reduced by lack of circulation at the points of contact or by the presence of an inhibitor.

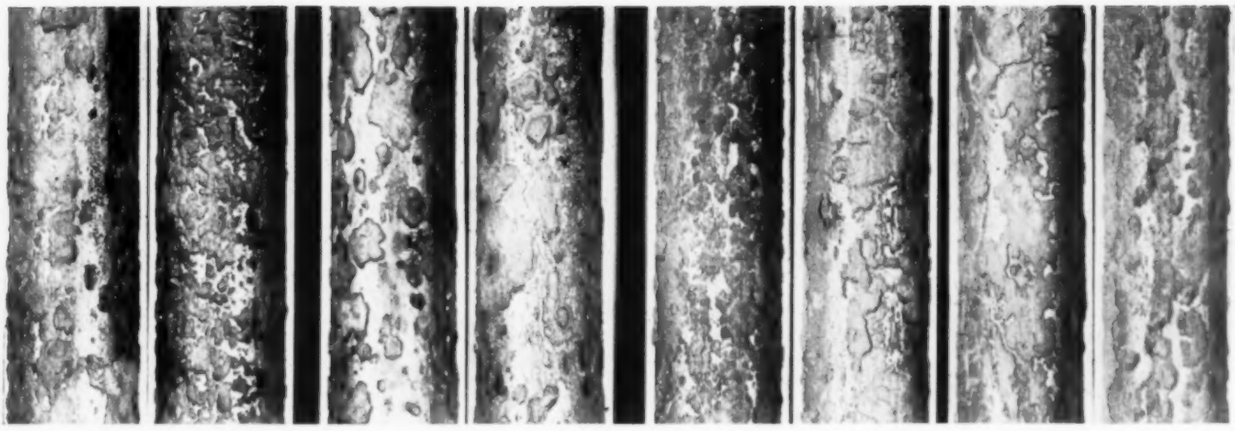
Corrosion and Stress

This is a destructive combination which has not been recognized in practice until recently. The more the data accumulate the more evident it becomes that the factors that control corrosion in metal carrying no load also influence corrosion of metal under stress.

Stress is one of several factors which tend to localize corrosion to certain spots on a surface, and cause a nick to develop, which, like any other break in the continuity of the metal, results in high local stresses and progressive fatigue fracture.

Oxygen in solution is an important accelerating factor in corrosion fatigue as it is in ordinary corrosion. When hydrogen is substituted for oxygen the effect of aerated water in lowering the fatigue limit is greatly diminished. Inhibitors like the chromates maintain a continuous oxide film on the surface in spite of the stress, and test pieces run in such solutions give as high or higher endurance limits than those run in dry air.

Moist air, or steam mixed with air, impinging on the metal under stress at high velocity is as destructive as a stream of corrosive water and lowers the endurance limit to the same extent. Steam containing the amount of oxygen usually found where a de-aerator is not em-



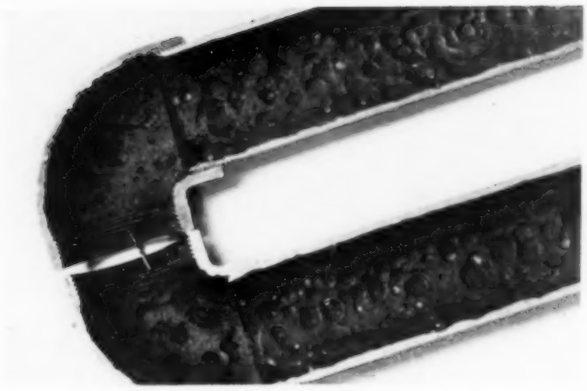
ployed in the boiler circuit, lowers the air endurance limit of test pieces, but the corrosion fatigue limit is much lower when a jet of steam is played on the specimen in air. Corrosion fatigue limits determined under the influence of a jet of moist air, or water in air, are about the same (approximately 20,000 lb. per sq. in.) and this figure apparently does not change very much for carbon or low alloy steels, regardless of the physical properties of the metal. Evidently corrosion factors control, not physical properties.

All the data so far available confirm the opinion that stress and chemical action are essential to develop the so-called caustic embrittlement in boilers. It follows, therefore, that dissolved oxygen in the boiler feed water (which is such an important factor in stressless corrosion) is also an important factor in corrosion of metal under stress, and should be strictly limited to the lowest amount practicable. Steam free from oxygen and carbonic acid is also probably one of the most important factors in securing long service from turbine blades.

Soil Corrosion Being Systematically Studied

Soil corrosion is distinguished from other types of corrosion by a more marked tendency to pitting. It has been found that the rate of penetration due to the soil water alone is not nearly so rapid as when the water is mixed with irregular soil particles. Electric currents have recently been discovered and measured flowing to and from pipe lines over considerable areas, apparently due to soil variations. When more is known about these currents and their origin, some of the mysteries of soil corrosion may be cleared up.

The data already at hand from the Bureau of Standards' soil tests after three inspections at intervals of two years indicate a difference of about 20 to 1 between the maximum depth of pitting in different localities, but practically no difference between any of the wrought ferrous metals on the general average. The tendency to pitting, as indicated by the pitting factor, varies from 6 to 20. (The pitting factor is the ratio of the depth of the deepest pit to the average depth of corrosion.) It is also to be noted that no one ferrous metal is superior to the others in all locations. It has also been demonstrated that severe pitting may occur in the absence of stray currents, and that as a rule the



influence of chemical and physical characteristics of the soils predominates over the influence of variation in the metals.

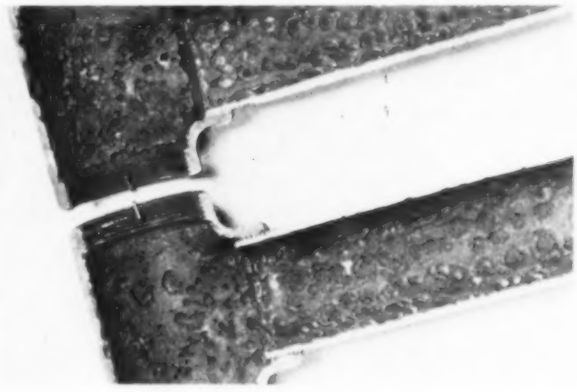
Data collected during the past year on soil corrosion make it seem possible that a scientific correlation of soil characteristics and corrosion will be developed before long. Some of the old pipe line companies have fortunately kept accurate records of replacements due to corrosion for 25 or 30 years. These records form a valuable basis for correlation of soil characteristics with corrosion, since they indicate considerable difference in the soils traversed by some of these lines.

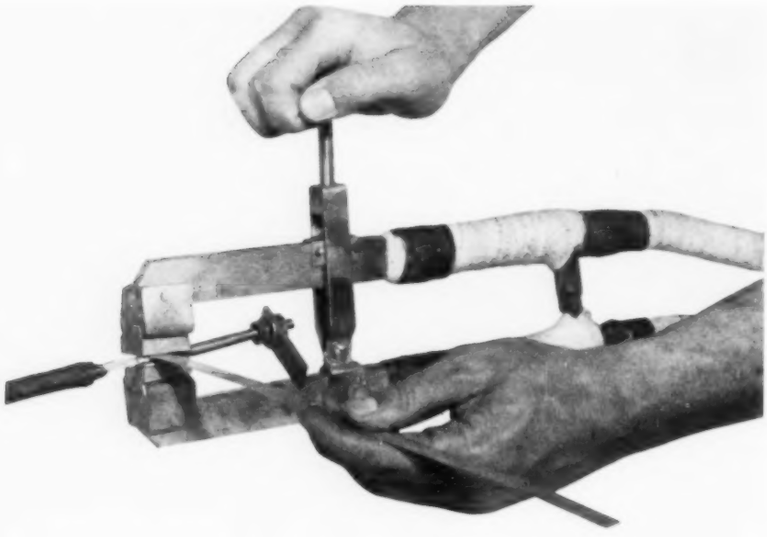
A study of the effect of local pitting on the strength of pipe shows that 20 pit holes scattered throughout a length and penetrating half way through the wall did not decrease the strength of the pipe materially.

Corrosion in Steam Plants and Heating Systems

Better control has been obtained over corrosion in boilers by more thorough de-aeration and by conditioning the water to produce a protective scale on the metal. Most water conditioning has aimed at a reduction in the amount of scale for economy of operation, but evidently it can be overdone. Recommendations of the American Society of Mechanical Engineers' boiler code committee should be adhered to until further experience is obtained.

A problem of long standing has much to do with the life of return steam lines in steam heating systems in certain districts. Some of this trouble is no doubt due to air leaking into the heating system proper through radiator valves, but "acid steam" is often a contributing factor of considerable importance. It is now recognized that feed water treatment should be controlled so as to produce the minimum amount of carbon dioxide and oxygen in the steam where damage from corrosion may be a serious matter. More work is being done to determine the conditions in boiler water that produce "acid steam." Elimination of oxygen in the feed water will go a long way towards correcting this trouble. As millions of dollars' worth of property are involved in steam heating systems, those concerned should cooperate in solving this problem in a practical way, thus following in the path of the most outstanding feature in corrosion study during the past year or two: namely, the organization of various interests to combat this waste by combining their resources into a cooperative work.





Carbon Blocks In the Jaws Are Heated By Low Voltage Electric Current, and Enough Heat Is Transferred to the Joint to Melt Borax Flux and a Drop of Silver Solder

Resistance Brazing

High strength joints made at low temperatures

ENGINEERS in various departments of the General Electric Co. have developed a new method of making joints in heavy electrical conductors, a method which has so many possible applications in other industries that complete equipment for it is about to be marketed. The close-up of a piece of typical apparatus illustrates the method quite clearly.

Cables leading from the low voltage winding of a transformer are fixed to steel jaws, each one of which contains a block of hard carbon such as is used for electrodes and brushes. The joint to be made is assembled, and gripped between the carbons by means of a screw-clamp properly insulated from the jaws to avoid short circuting at this fixture. A heavy current at about 10 volts is then passed through the jaws and joint. In a few seconds the carbons become red hot from internal resistance, and the heat is transferred to the parts to be joined. The resistance of the metal at the joint contributes but little to the work.

Within 10 or 15 sec., the carbon blocks are at a bright red heat, and the curent can be interrupted. Meanwhile the parts to be joined have reached the temperature where the flux sprinkled on the joint has melted and thoroughly cleaned the metal. The end of a ribbon of silver solder or other suitable brazing alloy is touched to the hot junction, where it melts and spreads out over the fluxed surface, and is drawn by capillary action into the tiniest crevices between plane surfaces. Proper brazing alloys and silver solders, when liquid, have the well-known effect of forming an alloy with the surface layers of metal, in spite of the fact that the parent metal is solid, far below the melting point at the time of making the joint.

With the current off, the whole assembly rapidly cools until the alloy "sets," when the

Bundles of Conductor Wires Are Quickly Joined By Localized Heat Without Damaging Neighboring Insulation

clamp can be loosened and used to assemble the next joint. On production work, this means that only about one minute is required for the entire operation, during which time the current is on a few seconds.

Auxiliary equipment is shown in the view on page 57 showing a workman soldering a joint in heavy conductor wire, intended for closely-wound coils where space does not permit a bulky joint. The clamp illustrated previously is in one hand, the hard silver solder in the other. His left foot is on the control switch, whereby current from a nearby power circuit is passed at will through the small transformer on the floor alongside. Flexible cables to the clamp at the joint complete the equipment. The transformer has 10 kva, nominal capacity, but is capable of 400 per cent overload, and would normally be wound with a suitable primary for connection to any 220-volt, 60-cycle power circuit. By means of three taps on the primary side, curent at 8, 10, or 12 volts can be used for the brazing operation; choice would depend upon the size and type of the joint to be heated.

An operator engaged in resistance - brazing connections in large electrical machinery is illustrated at the left. The various joints from coil to coil, and from coils to terminals, can be readily made between the bulky bundles of wire in very short order, with the minimum disturbance to the insulation, and in close quarters. Another fixture which requires less room than the one shown, operates on the principle of a bench vise. Still others utilize the idea of a C-clamp; others are arranged with fingers which can reach down into holes.

Close-ups of a pair of joints give ready comparison of the new method with the conventional leaded terminal. The terminal in one joint is merely a piece of copper bar, sheared and punched. In the other joint it is a longer piece of copper tubing, flattened at one end, trimmed and punched, weighing about three times as much. In the brazed joint, six braids would be laid on either side of the terminal bar, a small piece of thin copper sheet snipped to proper size laid for a cover, top and bottom.

The Small Transformer, Connected to a Power Circuit, Sends Current to the Clamping Jaws Whenever the Operator's Foot Presses the Switch

and the assembly clamped in the fixture. A minute later the joint is complete. In the leaded terminal, the 12 braids would be wired together, and both the end of the braids and the socket heated, either by torch or by pouring hot lead over them repeatedly. When at proper temperature, the two are slipped together and the cavity filled with melted metal.

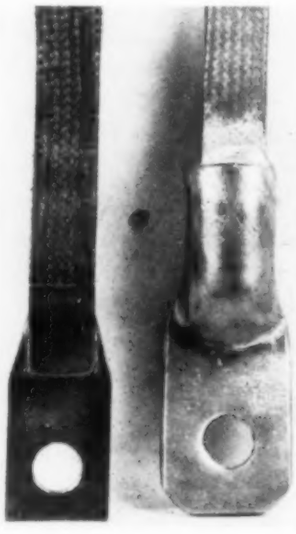
This description indicates that in close work with leaded joints it is sometimes very difficult to dispose the parts so the terminal will be vertical enough for pouring. Furthermore, much preparatory work is necessary to protect the adjoining work from splatter and from burning the insulation because of long heating time. Finally, the cost of lead used in such a terminal is about twice as much as the silver solder in the other, for only a few drops of the latter are necessary.

From a mechanical and electrical standpoint a brazed joint has characteristics superior to those of a leaded joint. When proper silver solder is used, the tensile strength can easily be made to exceed the strength of the copper itself — when joining copper bars, for instance, a lap of about 1½ times the width is sufficient to cause a test to break outside the joint. The specific resistance of the brazed joint is also less, and has less liability to heat locally when carrying electrical currents. Furthermore, if heated by any means, the joint does not soften until a temperature is reached far above that at which a leaded joint would fall apart.

Flux used in resistance brazing is ordinary fused borax, known as borax glass. A common method of using it is to sprinkle the powder on the assembled joint. If flat surfaces are to be brazed, they should first be wet with a water solution of the flux and then dried. Powdered borax in grease, and in alcohol suspension may also be used.

Silver solders with melting points in the range of 750 to 765 deg. C. have been most satisfactory for electrical connections. If high strength joints are to be made, hard solders melting at 875 deg. C. would be the choice. High heats are to be avoided when working with insulated wire, because more heat would be carried back from the joint to damage the insulation. Brazing at a higher temperature is also a more delicate operation — heat much in excess of the melting point of the bronze, brazing "spelter," or silver alloy should be avoided; otherwise the joint will lack the usual toughness and strength. For tough, strong joints, a minimum of alloying action, and a minimum of metal in the joint is an essential.

Brazed Joint Contains Less Copper and Is Electrically Superior to Leaded Terminal, as Well as Being Cheaper to Make



Temper to Avoid Grinding Cracks

LITERATURE on the grinding of steel gives a large amount of valuable information on the mechanical factors concerned, but little study has been made of the effect of heat treatment and solid nonmetallic inclusions on the grinding operation. Gerald R. Brophy, General Electric Research Laboratories, Schenectady, recently investigated these two phases and wrote a paper on the subject which he will present before the National Metal Congress in Chicago.

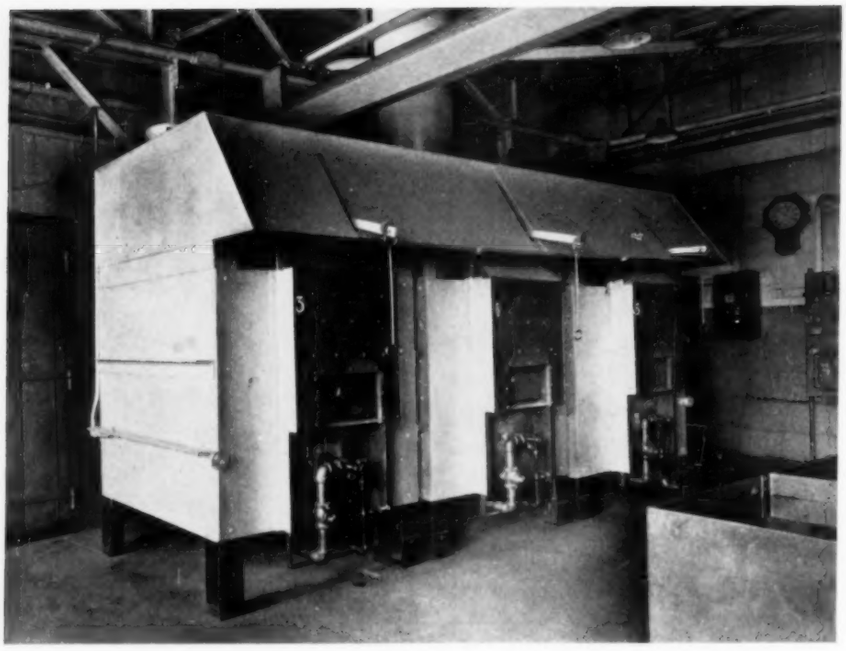
The removal of metal by the grinding wheel causes the steel immediately beneath the removed portion to heat up. This metal can expand only vertically because the rigidity of the surrounding metal prevents lateral expansion. The resulting bulge above the surface is at once leveled by the wheel, leaving the rest of the heated metal permanently upset. As the wheel passes away from the spot, the hot metal chills and shrinks. Since there is now actually less metal than is required to fill the volume after the bulge is removed, the metal on cooling and shrinking is stretched and remains highly stressed, if not broken.

Foreign inclusions or cementite network frequently cause excessive local heating during grinding, with consequent excessive stresses. That, together with the fact that these are points of weakness, logically explains the greater amount of cracking on steels of this type.

Grinding stresses can be considerably reduced by tempering before grinding to Rockwell C 59 to 60 or less, says the author. Tempering after grinding is equally important to reduce the total stress to a safe point. This is especially true of precision parts or of parts which must withstand high unit stresses.

By John C. Kielman

Practical Points on Furnace Design



Battery of Three Modern Furnaces For High Speed Steel. Furnaces No. 4 and 5 are for preheat; hearths are 30 by 36 in.; furnace No. 3 is for high heat and has a hearth 24 by 30 in. All are underfired by a single oil burner with automatic control. Note steel casings, ventilators at doors, and exhaust hood over the battery.

IN BUILDING heating furnaces there can be comparatively little standardization, because there is such a great difference in the purposes for which they are used. A furnace for heat treating high speed steel will naturally differ from one used for carburizing. A furnace for heating stock for a drop hammer will differ from one that is suitable for hardening straight carbon steels. The kind of fuel used, such as oil, gas, coal or electricity will also have a determining influence on the design of any furnace for a given purpose.

However, the art of heating metals has developed in a measure like our present mechanical arts, and during that development a few practical rules applicable to furnace design have been worked out, as well as quite a little theoretical knowledge. In this brief article an effort will be made to state some of the factors which have been gained by experience.

Conditions Affecting General Dimensions

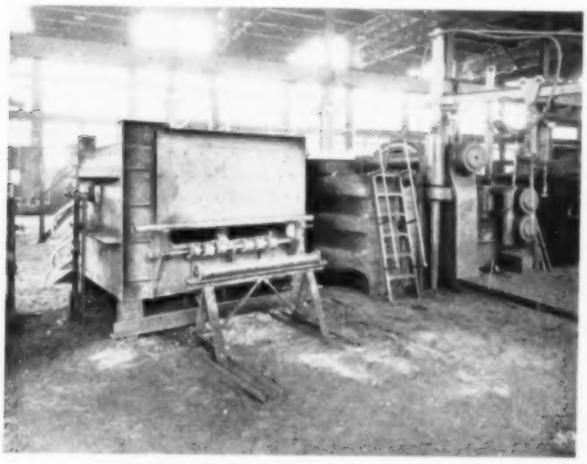
When designing a new furnace, the problem can be divided into several items, such as the purpose for which the furnace is to be used, the quantity of heat required by the amount of material to be heated, the kind of fuel to be used, the determination of all heat losses, the transfer of heat to the charge and the equalization of heat in the charge. These will now be briefly considered.

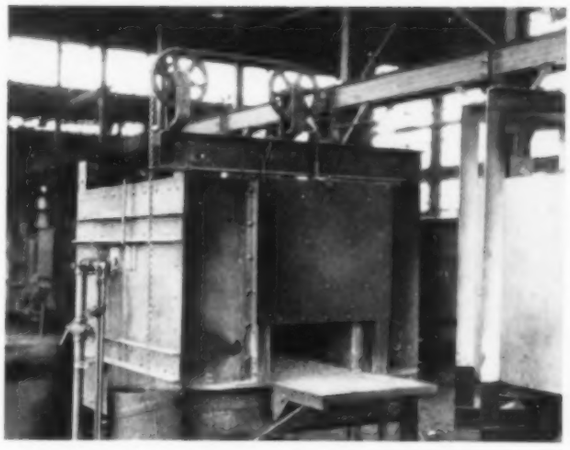
Purpose for which the furnace is to be used will govern its general characteristics, for it is likely that furnaces for similar work have been built elsewhere, and their suitability and efficiency is known. In such a case, a new furnace will be an improvement on an existing type, or a modification to make it more suitable for its purpose in new surroundings.

Amount of material to be heated and the required temperature will give the quantity of heat that must be imparted to the charge. Curves giving the heat content of all the common metals are found in the National Metals Handbook, pages 24 to 27, (1930 Edition). From these the quantity of heat can easily be figured. It is also easy to determine the quantity of heat required by multiplying the temperature range through which the metal is to be heated by its average specific heat. This is approximately 0.165 B.t.u. per deg. Fahr. for 1 lb. of mild steel and 0.175 B.t.u. for tool steel.

Fuel used in supplying heat has a decided influence on the furnace proportions, as proper provision must be made for combustion and disposal of its products. If electricity is used there is no problem in regard to combustion, but then the provision of proper atmospheric conditions within the furnace becomes important.

Heat losses can be determined approximately by comparative calculations for existing furnaces of similar design, or by calculation from reasonable assumptions after the rough preliminary design of the furnace has been made. Heat losses do not impair the capacity of a fuel fired furnace to the same extent as they would a furnace heated by electric resistors, because more heat can usually be supplied by combustion than can be absorbed by the charge.





Fairly Large Furnaces, Steel Encased, May Be Easily Moved. Both are direct fired with two oil burners. One has a 36 by 48-in. hearth and is used for heating miscellaneous blacksmithing for a 1500 lb. steam hammer; the other heats large round stock for upsetting in a bulldozer such as the one shown alongside.

Transfer of heat to the charge is essentially a surface action, because heat cannot be absorbed by metal bars until it is transfered to the surface. Convection, or heating by circulation of hot gases, is of considerable importance at low temperatures, but not so important when the temperature rises above a red heat. Heat transmission by radiation is much more energetic than by any other method, and it is well known to furnace men that a luminous flame will give the fastest heat transmission. One of the most difficult problems of operation is to maintain a luminous flame over the charge, keep excess oxygen away from the metal, and still have complete combustion so as to prevent fuel waste.

Rate of heating for steel stock under 3 in. in diameter is limited by transmission into the surface, but for stock over 4 in. in thickness the rate of heating depends on the properties of the material, such as its density, conduction and the permissible temperature difference between the surface and interior.

Proportions of Walls and Roof

After the general proportions of the furnace have been figured along the above lines, many details of a practical nature must be decided. Customary usage or previous experience will often furnish a valuable guide.

Furnace walls, for instance, should have a minimum thickness of 4½ in., and should be supported and braced at least every 3 ft. For a greater distance between supports, or for temperatures above 1600 deg. Fahr. the thickness should be 9 in. Small oil-fired forge furnaces often have 9-in. walls, laid as headers, with a 2½ in. insulating wall and a shell of ⅛-in. steel plate on the outside. This construction makes a very durable furnace, with brick work well supported, and provides enough insulation to save most of the heat that would be wasted through the walls. Larger furnaces are usually held together by tie rods and buckstaves. The more closely these are spaced the more rigidly the furnace is held together.

The roof of a furnace helps hold the side walls in place by pushing them out against the buckstaves. Roof bricks are subject to severe service because they must carry the weight of the roof across its span and resist strains due to expansion and contraction, in addition to resisting the heat to which it is exposed. It is comon practice to make the radius of curvature equal to the span, which gives a 60 deg. joint at the spring line, and a rise equal to about 13½ per cent of the span. The minimum brick thickness for a span up to 4 ft. is 4½ in., and for a span up to 12 ft. is 9 in. It is good practice to build all small furnace arches 9 in. thick because of their increased durability and reduced heat loss. Long spans are often broken up into smaller spans, or made of tile suspended from girders; this is common practice in steam boiler furnaces. Roofs of high temperature furnaces are generally not insulated because the radiation of heat cools the brick and enables it to carry the load better. While this is a great source of heat loss, especially in high temperature furnaces, it is the only way the roof can be maintained.

If an arch is rigidly held at the ends by beams behind the skewback, the expansion, which amounts to about 0.075 in. per ft. for fire clay brick between room temperature and furnace temperature, will cause it to bulge and rise in the center. This slight deformation usually causes no damage and the arch settles back when the furnace cools again. In long arches at high temperature an undue rise would be counteracted by slackening the tie rods.

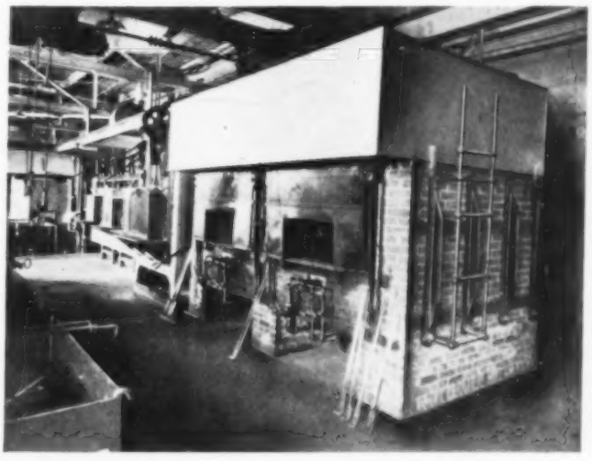
Hearths Require Careful Installation

The hearth of a small furnace seldom presents difficulties or makes trouble up to 1600 deg. Fahr., but when the temperature is 2000 or more, certain problems arise. If the furnace has a solid bottom under the hearth reaching to the foundation, the bricks forming the hearth may then become mushy because so little heat is radiated through the foundation. A ventilated hearth, under which the air can circulate, eliminates this difficulty. Hearths, like roofs, should be cooled to prevent rapid failure.

Scale from the stock being heated has a chemical action on fire brick. Scale is a basic oxide of iron, and fire brick is acid oxides of silicon and aluminum. These unite to form a

fusible slag, consisting of iron and aluminum silicates. Fire brick bottoms, therefore, require constant renewal. Silica sand and crushed silica rock are consequently often used for furnace bottoms, and crushed fire brick can be used in some cases. The slag formed can then be easily removed on account of the friable nature of the bottom, and the latter is replaced at little expense. Many heating furnaces are built with a sloping hearth from which slag can be drained through a slag hole when enough accumulates. Sand is not used in forge furnaces because it sticks to the stock resting on it. A neutral or basic refractory, like chrome brick or plastic chrome ore, will resist the scouring action of hot scale, but such material is expensive.

Although a solid hearth will tend to become mushy if the furnace is large or the temperature high, small furnaces that are not built with steel jackets are usually built with a solid hearth on a concrete foundation. The minimum thickness of firebrick in such a case is about one-sixth the width of the furnace for 2200 deg. Fahr, and one-eighth the width for 1600 deg. Fahr. In no case should it be less than 9 in. This is to keep the temperature of the concrete foundation below 900 deg. Should the furnace be built with a bridge wall and used at forging temperature, the bridge wall should be about two-thirds as wide at the top as its height.



Types of Well Built Brick Furnaces, Strongly Braced With Buckstaves, For Hardening and Annealing Drop Hammer Dies and Other Sizeable Tools. Note ventilated hearths, doors and hoods. Furnaces are underfired and have carborundum hearths 39 and 48 in. wide.

When a piece of metal is heated on an ordinary hearth, it receives no heat from below except what the hearth has previously absorbed. Experienced hardeners realize this, and move pieces they are hardening so that they rest on a hot part of the hearth. An underfired furnace has the advantage of heating the piece from below, and this makes it desirable, although such a design has many other limitations. It is more difficult to construct, its cost is higher, its heating capacity is less, and its life is shorter. But for many purposes it offers the best solution. In its design, two contradictory principles must be balanced: To transmit heat well the hearth should be thin, but to carry a load it should be thick. Hearths for small underfired furnaces for ordinary hardening can be made of 3-in.

fireclay slabs, with piers 12 to 16 in. apart. For high speed hardening, or where the hearth is subject to much abrasion, or where better heat transmission is needed, slabs of carborundum answer the purpose. Carborundum can be used in much thinner sections than fireclay because of its greater strength. This is a double advantage because it improves the already superior heat transmission due to the qualities of the material. The capacity of underfired furnaces is low, being 10 to 30 lb. per sq. ft. hearth area per hr.

Flame and Flues

Every fuel fired furnace must have flues, ports or stacks to carry away the products of combustion. Their purpose is not to create a draft, as in boiler and smelting furnaces, for the pressure in a heat treating chamber must be equal to the atmospheric or slightly above. To secure this condition the flues should be placed as near to the hearth as possible, so that the flames "lick the hearth." Often flues are purposely made too large, but placed near the doors, so that if excess air enters it will be short circuited to the flues. If the flues are built too large they can be partly closed by fire brick; if they are too small they must be rebuilt.

In order to arrive at a figure for the area, based on the area of the hearth, let us assume that heating 60 lb. of steel per sq. ft. of hearth per hr. is a good rate. Adding 33 per cent for a factor of safety, let us plan on handling enough fuel to heat 80 lb. of steel to 2000 deg. Fahr. per sq. ft. per hr. Heat content of steel is about 324 B.t.u. per lb. at this temperature; the heat required is then 80 x 324 = 25,920 B.t.u. per sq. ft. of hearth per hr. Assume flue gas losses of 50 per cent at 2000 deg. Fahr., and losses due to radiation and other causes of 20 per cent. This leaves 30 per cent of the heat in the fuel available for heating the stock, and this portion must supply the 25,920 B.t.u. needed for useful work. To supply this enough fuel must be burned to give a total of 86,400 B.t.u. per sq. ft. of hearth per hr. To supply 10,000 B.t.u. from the combustion of oil will require about 95 cu. ft. of free air at room temperature, and the gases of combustion will have slightly greater volume, say about 100 cu. ft. at room temperature (per 10,000 B.t.u.). Their volume at 2000 deg. Fahr. will be 473 cu. ft. (per 10,000 B.t.u. generated). For 86,400 B.t.u. the volume of gases will be 8.64 x 473 = 4086.7 cu. ft., which is the volume that must pass through the flue each hour for each square foot of hearth area. The velocity, if the pressure at the port opening is 0.01 of water, will be 14 ft. per sec. The flue area required will then be equal to

$$\frac{4086.7 \times 144}{14 \times 60 \times 60} = 11.67 \text{ sq. in.}$$

for each sq. ft. of hearth area at 2000 deg. Fahr. heating 80 lb. steel per hr.

In a similar manner, the flue area required per square foot of hearth area for an underfired furnace heating 30 lb. per sq. ft. to 1600 deg. Fahr. is found to be about 3 sq. in., but in actual practice should be slightly larger.

It is as necessary to have the combustion chamber in an underfired furnace large enough as it is to have the flues the right size. To indicate how this is computed let us figure the requirements of the underfired furnace mentioned just above, having a heating capacity of 30 lb. of steel to 1600 deg. Fahr. per sq. ft. of hearth area per hr. The heat content of this steel is 250 B.t.u. per lb., and the total heat requirement is therefore 7500 B.t.u. per sq. ft. of hearth per hr. The loss due to heat carried off in the flue gases will be about 40 per cent at 1600 deg. Fahr., and the radiation and other losses may be assumed at 20 per cent. This leaves 40 per cent of the heat in the fuel available for the stock. To supply the 7500 B.t.u. needed, enough oil must therefore be burned to give a total of 18,750 B.t.u. per sq. ft. of hearth per hr. This equals 5.2 B.t.u. per second. With thorough mixing of fuel and air, fine atomization and perfect utilization of combustion space, about 8 B.t.u. per cu. ft. per sec. can

be liberated. If we extend the combustion chamber under the entire hearth it should have a height of $5.2 \times 12 \div 8 = 7.8$ in., or approximately 8 in.

Door Construction

Most furnace doors are of the lifting type. Their size is determined by the requirements of the work. On furnaces up to 1600 deg. Fahr. they offer no particular difficulties, as they can be made of cast iron or structural steel and lined with $2\frac{1}{2}$ to $4\frac{1}{2}$ in. of firebrick or sil-o-cell cement, which is about half as heavy as firebrick and has about one quarter the conductutivity for heat.

At higher temperatures doors are more difficult to maintain. For lightness they are often made of structural steel and lined with $4\frac{1}{2}$ in. of firebrick, but the heat losses are very high. Where there is more than one door, the wall space between them should not be less than 2 ft.

Furnace capacity is dependent on so many factors that it is difficult to make a general statement. There is a vast difference between heat treating fine tools and heating ordinary steel for drop forging. A small underfired muffle furnace will differ greatly in heating rate from a large continuous furnace for heating billets. The material to be heated also has a determining influence on capacity. Nonferrous metals give capacities proportioned to their density and conductivity. This does not hold exactly for some metals that radiate heat readily, such as silver and copper. These metals cannot be heated as fast as the above rule would indicate. A furnace built for heating steel could heat about $2\frac{1}{2}$ times as much copper if some other factor did not limit it.

Ten Practical Rules

Some of the practical rules for determining heating capacities, which can be used as a guide in planning furnaces are:

1. Heat penetrates into steel about $\frac{1}{8}$ in. in 5 min.

2. Steel for drop forging can be heated at the rate of 8 to 10 min. per inch thickness.

3. Forging ingots or bars larger than 3 in. thick can be heated at the rate of 20 min. per inch thickness of carbon steel, and 30 min. per inch thickness of alloy steel.

4. Carbon steel can be heated at the rate of about 30 lb. per sq. ft. hearth area for heat treating, 60 lb. per sq. ft. hearth area for annealing, and 80 lb. per sq. ft. hearth area for forging and rolling.

5. For very thin material the maximum rate of heating is about 160 lb. per sq. ft. hearth area per hr. This is based on the amount of fuel that can be burned.

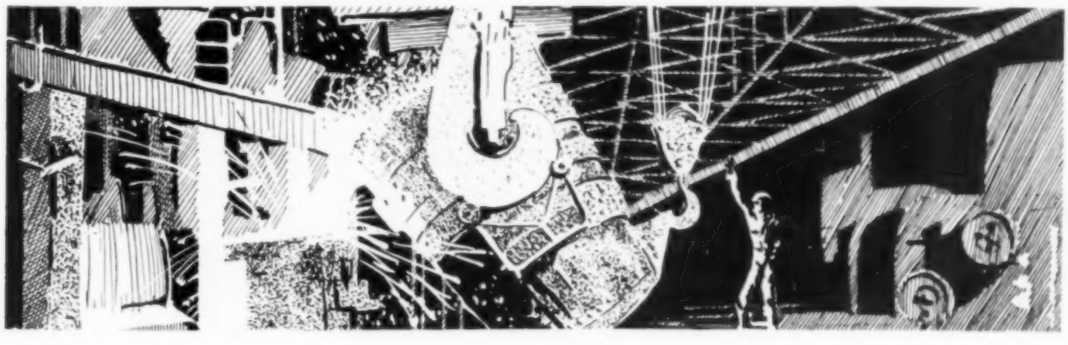
6. In continuous furnaces 50 to 80 lb. carbon steel can be heated per sq. ft. hearth area for forging or rolling.

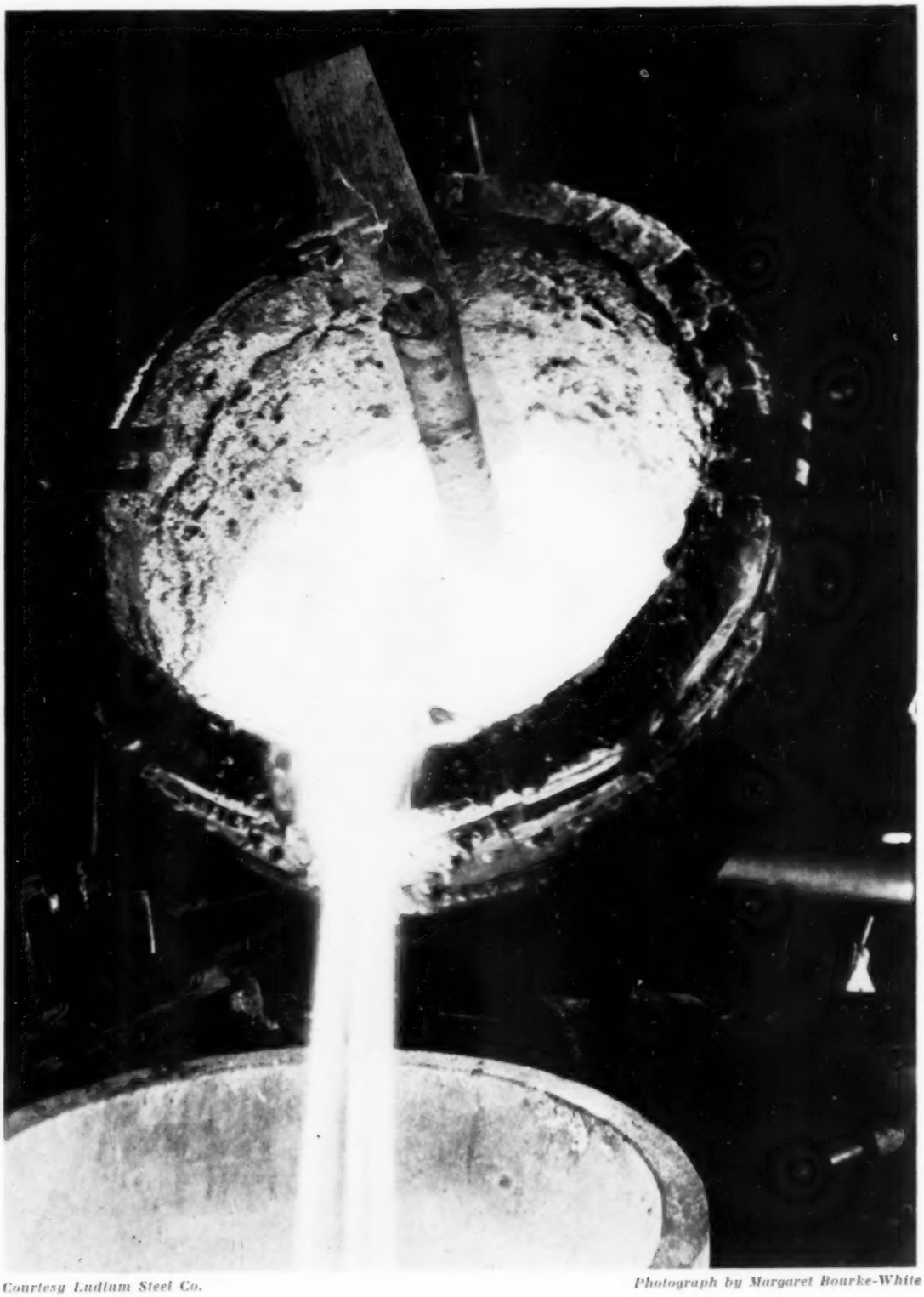
7. The capacity of small fire clay muffles is about 20 lb. steel per hr. per sq. ft. hearth area at 1600 deg. Fahr. Larger clay muffles have a capacity of about 15 lb.

8. Carborundum muffles have a capacity nearly 75 per cent of a direct fired furnace. Cast iron or alloy muffles have nearly the same capacity as direct fired furnaces.

9. The capacity of a metallic resistor electric furnace is about 3 kw. per sq. ft. of resistor-covered wall or roof, and about 50 lb. per sq. ft. of hearth area.

10. The capacity, based on volume, of a small direct fired oil furnace of good proportions is about 6 B.t.u. per cu. ft. per sec.





Courtesy Ludlum Steel Co. *Photograph by Margaret Bourke-White*

The End of the Heat

FROM THE PRESIDENT TO THE MEMBERS

IN PRESENTING THIS, the first issue of METAL PROGRESS, as the official monthly publication of the American Society for Steel Treating, we are confident that it will promote the desire of the Board of Directors to make the Society, as well as the services it offers, of the greatest possible benefit to its members.

Publication of METAL PROGRESS is directly in line with Article II of the constitution of the American Society for Steel Treating, which reads as follows:

> *"The object of this Society shall be to promote the arts and sciences connected with either the manufacture or treatment of metals or both."*

To fulfill these objects, the directors of your Society in one of their first official acts authorized the publication of TRANSACTIONS. With the passing years the amount and variety of material which logically found its place into the pages of your monthly book became so varied that it was realized that the possibility existed for three separate and distinct publications, and last February the Secretary was authorized to develop this ideal.

The previous monthly TRANSACTIONS now becomes a bound volume, which will be issued semi-annually. An assistant secretary has been given a special assignment to secure and present to the members even more of the highest grade of technical and investigational literature than has before been published.

News of current activities within the chapters and in the national office will be presented vivaciously in THE REVIEW, a monthly newspaper of tabloid size. Two copies of THE REVIEW have already been mailed and indicate fully what may be expected of this publication in the future.

METAL PROGRESS, the third unit of this publication plan, is now in your hands. It will warrant your closest attention. It speaks for itself better than I can speak for it. I am sure that you will agree that the addition of METAL PROGRESS with its enlarged editorial scope, its increased size, and its mechanical improvements without any increase in dues, fulfills in great measure the desire of your Board of Directors to provide the members with the greatest possible service at a minimum of expense.

This BON VOYAGE letter would not be complete without an expression of sincere appreciation to the officers and members of the various chapters of the American Society for Steel Treating who have without exception so splendidly responded to the request for material for the early issues of METAL PROGRESS, and at the same time I wish to acknowledge the splendid support and cooperation of those firms whose advertising appears in the pages of this publication.

Robert J. Guthrie

PRESIDENT

CLEVELAND, OHIO · AUGUST 1930

Getting Ahead . . .

Some hopeful people believe the world is getting better. Other pessimists are just as sure that the net change is backsliding. Most people don't think about it at all.

We are among the optimists. Metal Progress, the very title, represents our creed. It is only necessary to call to mind the quality and variety of metals and alloys now readily available for man's handicraft, and compare the situation which existed before the Bessemer and open-hearth process was invented, to prove the fact that we are immeasurably better off now than we were a century ago. Nor is the limit yet reached.

The near future will see many advances from our present stage, and METAL PROGRESS has been created to spread the news about the production, fabrication and utility of these new or better metallurgical products.

It may be an exaggeration to say that more progress has been made in the last 100 years than in the preceding 100,000. Advances in science and engineering, chemistry, physics, medicine, applied electricity and mechanics have indeed revolutionized the entire mode of life in industrialized nations in the space of a single generation.

But are we better off than our fathers and mothers?

Machines, not men, are now the drudges. But has the worker lost his joy of creation, and inherited, instead, monotonous performance at high speed? Is the sum total of human happiness increasing?

Sentimentalists have enjoyed themselves painting a dark word picture of Tony the wop, all day tightening bolt No. 67-A on the Ford production line. Not a highly exciting occupation, true enough, but certainly no worse than sledging stone in his native Sicily. Perhaps the greatest advantage of the job on bolt No. 67-A is that if Tony gets tired of it, or fired from it, he can get into his own Ford and next month be working in the orange groves of Southern California. Once a stone breaker in Sicily, always a stone breaker—father and son. No stone to break, no bread to eat. Tony, and especially Tony's children, are better off in Detroit than in their ancestral island.

Many such workers in our capitalistic and mechanized civilization are machine tenders—"slaves to the machine" in lurid phrase—yet the machines have set them free. Every foot-pound of muscular energy thrown back on the machine leaves one foot-pound of energy available for other activities. Doubtless the energy so gained is for the most part wasted. Granted that little of it is spent even approximately according to the approved ideas of various social and educational uplifters. Yet the potentiality, at least, is there. Ten million Tonys are freer to come and go and have more leisure and energy to enjoy themselves and improve themselves and their surroundings, than their fathers before them.

This is real progress. The net effect on the sum of human happiness is undoubtedly on the credit side of the ledger. This credit comes to the machine, the metals of which it is made, and the intelligence with which it was created and utilized.

The Merit Index . . .

Is it possible to devise some method of appraising the quality of steel by figuring a "quality factor" or "merit index"? How much relative weight should be given to the tensile strength, to the impact strength, or to the ductility exhibited in the test pieces?

Such questions as these were resurrected by Prof. Bradley Stoughton of Lehigh University at the June meeting of the American Society for Testing Materials, and started one of the most animated discussions recently enjoyed in an open meeting of that organization. Several speakers advanced data supporting the opinion that to weigh the relative merit of steels, strictly comparable test data must be chosen, and furthermore, that an intelligent selection of chemical analyses and heat treatments must be made. It is obviously impossible to use the same test

and formula to compare metals suitable respectively for rails, welded pipe and razor blades.

Professor Stoughton used eight different formulas for merit index which have been proposed in the past. When using the same test data for a group of carbon and alloy structural steels, he found that the relative ranking depends upon which of these eight formulas is selected.

For instance, the ultimate strength and the yield point in the annealed or as-rolled condition are substantially the same for the 3½-per cent nickel steel and the 1½-per cent manganese steel (approximately 100,000 and 60,000 lb. per sq. in. respectively), but the former has a better reduction in area while the latter has a higher elongation. Therefore, any merit index which emphasizes the percentage elongation will show that the medium manganese steel is superior to nickel steel, whereas any formula which emphasizes the reduction of area will indicate that the nickel steel should take first place.

Brief consideration of the commercial and engineering use of the modern structural steels makes it apparent that many things besides the tensile and impact strengths will influence the engineer in making his selection. Cost is the ruling factor in practically every instance. Cost is a total of a large number of items having little relationship to tensile and impact strengths. A large tonnage of 3¼-per cent nickel steel could be used on the Delaware River suspension bridge economically because a large amount of scrap armor plate and gun steel was on the market and could be used in its manufacture. At that time nickel steel cost only 11 per cent more than silicon structural steel, yet it was stressed 22 per cent higher. On the other hand, when bids came in for the suspension bridge over the Hudson River, the price for nickel steel was about 21 per cent higher than silicon steels, since the stock of cheap raw material was no longer available. On that basis nickel steel and silicon steel would be about equivalent, unless the nickel steel could be stressed even higher than it had been in the past, or unless large savings through collateral advantages could be expected.

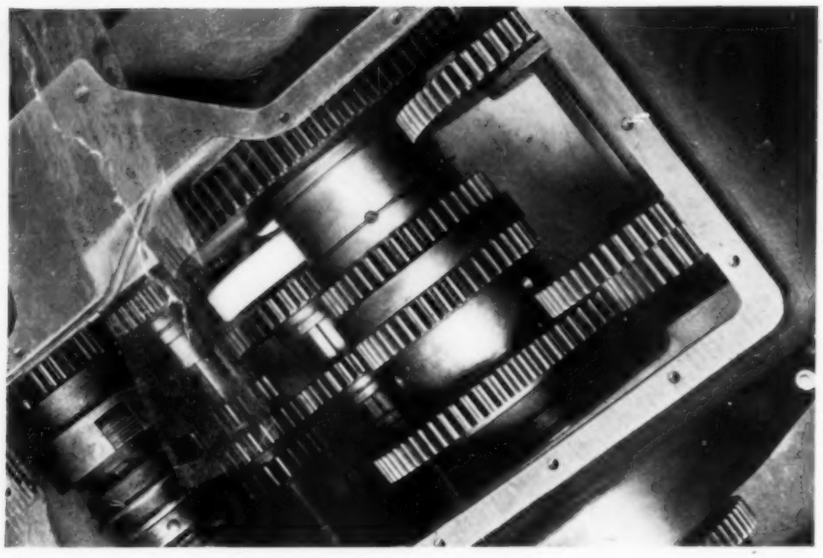
Every metallurgist knows that in most applications of the heat treated steels, alternative analyses are available. One gear shop with high reputation for quality product may use almost exclusively a mild nickel steel, case hardened. Another does just as good a job with a medium chromium steel, fully hardened. Each analysis, properly treated and in the hands of men experienced in its use, gives an entirely dependable product. They are equivalent in this respect, no matter what the merit indexes say. Yet it would be a matter of grave consequence for these two shops to switch steels.

First choice of well informed engineers will rest primarily upon experience and the service records of a metal in the same or similar parts, and secondarily upon tensile tests and impact values. The latter are most valuable for routine inspection, production control and laboratory development. Service is the best merit index.

Come to Chicago . . .

On page 94 of this issue is printed a brief story about the program of technical activities and the plans for the exposition of metals and metallurgical equipment to be held in Chicago during the latter part of September. Several of the other articles are brief abstracts of the important papers to be presented for discussion — obviously only a few of the fifty or more equally worthy of attention could be selected for presentation.

Perusal of this matter will reinforce the conviction that the time and money required to attend and participate in the National Metal Congress in Chicago will be well spent indeed. The return will be a fund of ideas and a group of acquaintances, the value of which no one can appraise, for acquaintances and ideas are of priceless worth in slack times no less than during a business boom. A common criticism of conventions, namely, that the delegates spend too much time on board walk or golf course, cannot be levelled at Chicago, for here all activities — even eating and sleeping — are housed under one commodious roof.



The nest of gears in the head of the new Warner & Swasey universal hollow hexagon turret lathe.

Lathe Transmission Gears

Production Hardening Methods

by Donald M. Gurney

TWENTY-FIVE is the average number of gears in the transmission head of every one of the semi-automatic direct drive, hollow turret lathes manufactured on a production basis by the Warner & Swasey Co. of Cleveland. Since the gears vary in weight from 2 to 160 lb., and in diameter from 2 to 22 in., they present one of those problems which are best solved with up-to-date heat treating equipment, thoughtfully selected and operated.

Elimination of noisy and inefficient gears is as desirable for the product of the machine tool builder as for the automobile. Machinery tolerances in years gone by were expressed in sixty-fourths of an inch — they are now specified by ten-thousandths. It is the function of the heat treating department to insure that gears which have been machined to these tolerances are not spoiled by scale formation or warpage.

Flow of work in a straight line is of course ideal where the quantity is large enough. Such an arrangement has been made for treating these gears. Because of their size, the largest gears are treated in oil-fired muffle furnaces, but there are enough of the smaller gears to warrant the installation of a battery of electrically heated units. As shown in the view, this latter equipment consists of two salt pots, each

with a capacity of 250 lb. of work per hr., a quenching and a cleaning tank, and a hot air tempering furnace of equal capacity.

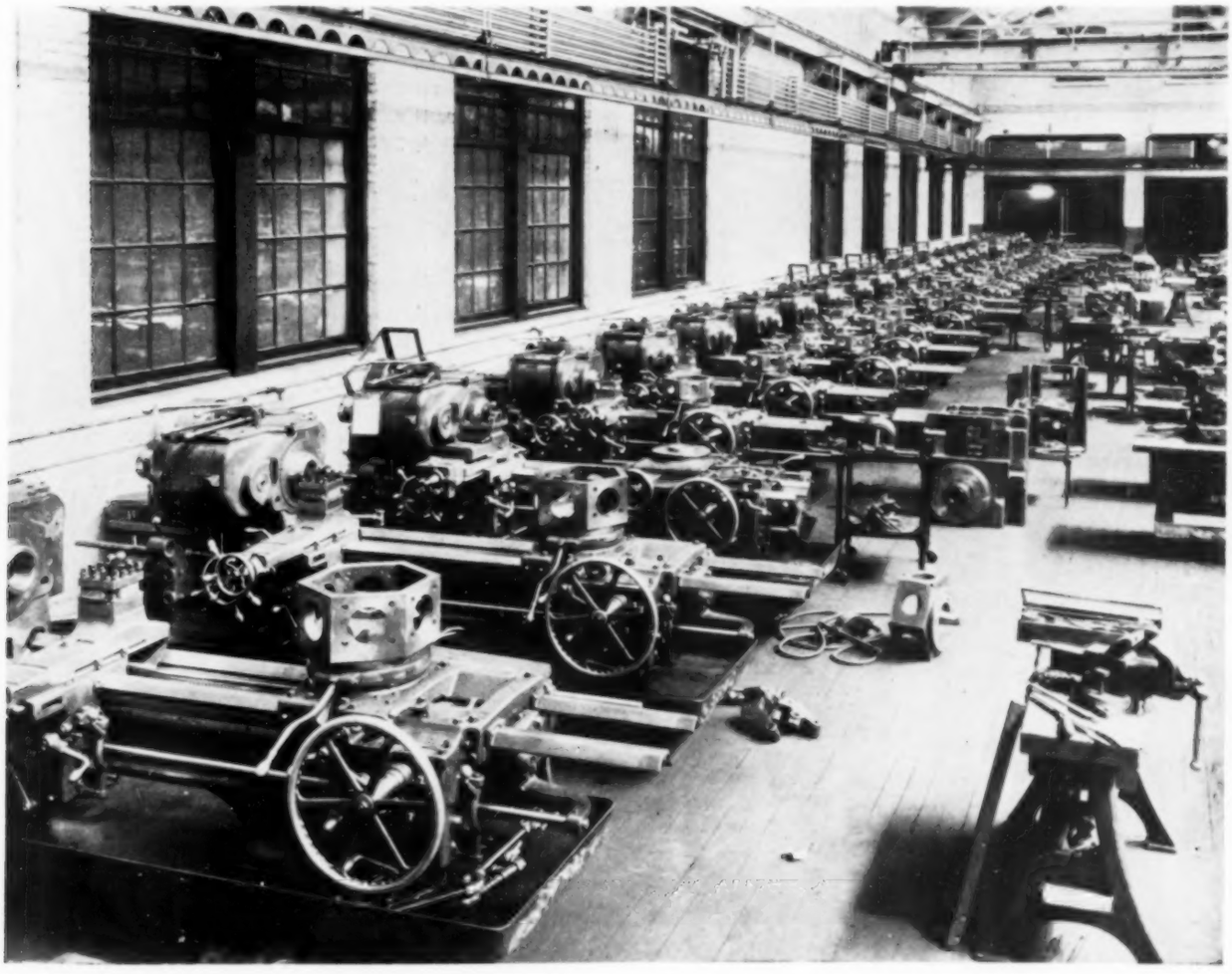
Blanks are Annealed and Normalized

The gear blanks, forged from S.A.E. 3150 steel (carbon, 0.45 to 0.55; chromium, 0.45 to 0.75; nickel, 1.0 to 1.5) are delivered to the heat treating department in the as-forged condition. They are then normalized and annealed in the oil-fired furnaces to remove forging strains and make ready for machining.

Normalizing practice consists of air cooling from 1600 deg. Fahr., followed by a 1525-deg. anneal with furnace cooling. Every blank is then brinelled and must show a hardness number not higher than 217 and not lower than 187. Experience has shown that, when the usual normalizing and annealing procedure is followed, the blanks with hardness outside this range are not forged from the proper steel, and a chemical analysis is then demanded.

After the teeth are cut and the gears accurately machined all over, they are returned to the heat treating department. Each is suspended on a hook or fixture made of nickel-chromium steel rod. Several of these fixtures, properly loaded, are heavy enough to handle by an air hoist which travels on a monorail above the line of furnaces.

One of the salt pots is used to preheat the gears to a temperature between 1250 and 1275 deg. Fahr. Preheating serves to hasten the heating cycle by doing away with a drastic drop in the temperature of the molten salt when cold material is placed in it. Two thermocouples serve each furnace; one is located within the heating chamber and one in the salt itself. Accurate information on the progress of preheating is obtained by observing the differential between the two readings, as shown on an automatic temperature recorder and control.



Heating to a hardening temperature is done by transferring the preheated work to the second salt pot, located immediately alongside. This pot has its own automatic recorder and control unit, placed immediately beside the one for the preheater, which also records readings from thermocouples in the pot and in the heating chamber. The gears are quenched from within the range of 1450 to 1475 deg. Fahr.

Air Hoists Used

The quenching medium is circulating oil. The circular tank is located beside the hardening pot, and is set in the floor to within two feet of its top. When the gears are up to heat, they are raised from the pot by the hoist (which is then pushed on the rail to a position directly above the quenching tank). Then the gears are immediately lowered into the coolant.

The hoist is equipped with self-actuated reversing levers which can be set to operate at will. Since the piston length of the hoist is slightly less than the depth of the tank, the operator merely has to set the reversing mechanism and the work will be alternately raised and lowered through the oil. This prevents soft spots on the steel from clinging air bubbles.

When the work is thoroughly cooled, the reversing motion is stopped and the hoist used to lift the gears from the oil and lower them into a kettle of tri-sodium phosphate kept boiling by waste steam. Mechanical agitation is again used, this time to wash away any film of oil remaining from the quench. The soda kettle also serves as an efficient preheater for the tempering furnace. The gears are probably heated to about 200 deg. Fahr. before they enter the tempering furnace, where they are held for two hours at 475 deg.

Hardened and tempered gears are wire brushed to remove any adhering foreign matter such as particles of oil or salt. Formation of scale is prevented by the use of salt baths, and by the rapidity with which the gears progress from the pre-heating to the final tempering furnace. Transfer from pot to pot is very rapid, and there is small chance for the hot metal to come in contact with the outside atmosphere.

Each gear is brinelled separately as an assurance of accurate heat treating, and unless within the required hardness range of 512 to 532, fails to pass inspection.

Electrically Heated Pot Furnace Equipment for Hardening Lathe Transmission Gears. Air hoist is centered over quench tank, and tempering furnace is at the rear. Note connections for thermocouples, one through top into salt bath, one through rear of casing into heating chamber.

New Zeppelin A-Building

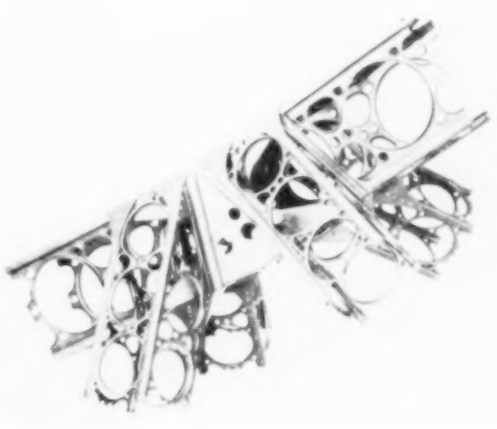
•

ZRS-4 will be the next monarch among airships. It is being built for the United Navy at the Akron plant of the Goodyear-Zeppelin Corporation. Larger than the famous Graf Zeppelin, larger even than the new British dirigible, R-100, which recently crossed the Atlantic, the ZRS-4 will be the greatest ship of the air. Launching of its twin, the ZRS-5, is scheduled for May, 1932.

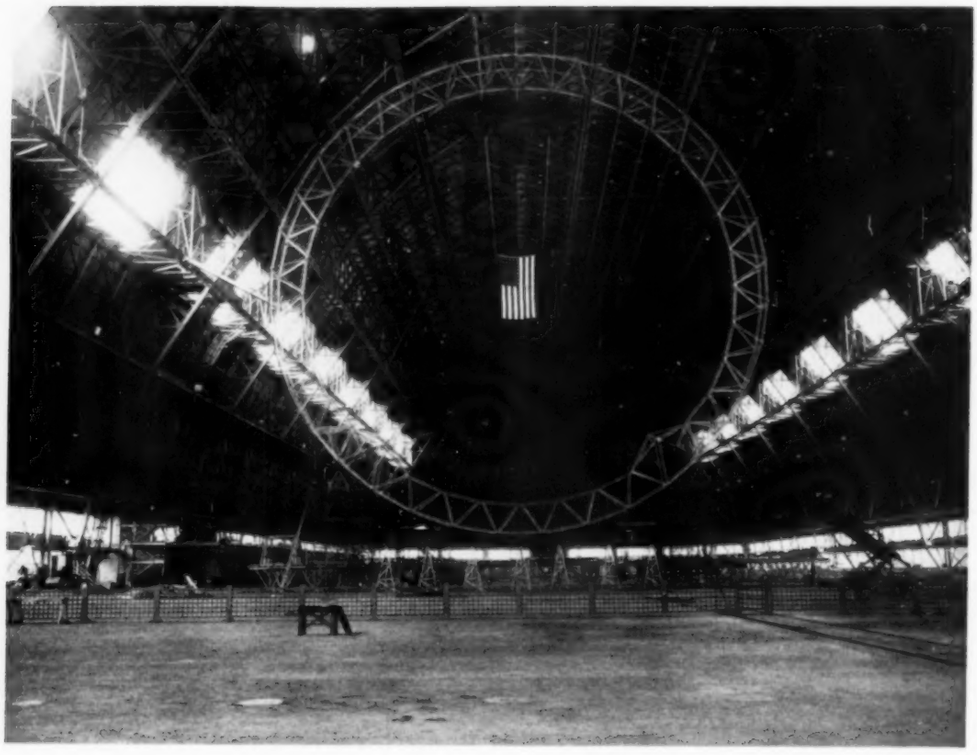
Dr. Karl Arnstein, builder of more than 70 airships at the Zeppelin Works in Friedrichschafen, Germany, who went to Akron as vice-president and director of engineering for the Goodyear-Zeppelin Corporation, designed the ship. It is being built on the conventional three-layer principle: a dirigible with a rigid metal framework to withstand the major stresses, gas cells within to confine the lifting gas, and a taut fabric outer cover to offer a smooth flying surface and to shield the ship from the elements.

The metal skeleton of the ZRS-4 is made of 17-S, a high strength aluminum alloy manufactured by the Aluminum Co. of America, containing 95 per cent aluminum, 4 per cent copper, 0.5 per cent magnesium, and 0.5 per cent manganese. The alloy, which has an ultimate strength of 55,000 lb. per sq. in., and a yield point of 15,000 lb. per sq. in., is furnished as sheets in the heat treated and tempered condition. The standard sheets from which the skeletal girders of the ZRS-4 are stamped, are 16 ft. long, 24 in. wide and in both 0.041 and 0.125 in. thicknesses. In fabrication it is quenched in the ordinary way, to soften it, and worked immediately before the age hardening effect develops.

A Detail of the New Zepp's Skeleton.



Dr. Arnstein's design for the main ring girders of the ZRS-4, a detail of which is illustrated, provides for the elimination of all excess weight by the exclusive use of the punched and flanged girders of aluminum alloy. Rivets of the 17-S alloy are used throughout the framework. When construction began, segments of



The First Ring in Position. Large as it is, the ring seems almost a spider web in the great hangar at Akron.

the main ring were fabricated at the stamping and designing building, over a mile from the hangar, and carried to the hangar by truck. Since August 2, however, all fabrication work except stamping has been done at the hangar.

The stamped sheets are now riveted into segments and then assembled in jigs for final fabrication. Only three sizes of rivets are used, 1/8 in., 3/32 in. and 5/32 in. Before use the rivets are annealed in electric furnaces, 25 min. for the two smaller sizes and 45 min. for the 5/32 in. size. When the specified time is up the rivets are quenched in water. Within one hour after annealing the rivets regain much of their previous hardness, so hourly all unused rivets are collected and a freshly annealed supply left for the construction crew to use. Rivets may be re-annealed as often as necessary.

Ready to Hoist. One of 14 rings for the ZRS-4 has just been built and the jigs and templates removed.

Driving rivets into structural steel is probably one of the world's noisiest jobs, but aluminum riveting is otherwise. The rivets are hand squeezed, not pounded with air hammers, by a device which looks like a nut cracker with handles about 18 in. long. The riveter compresses the ends of one annealed rivet at a time, a single squeeze being sufficient to do the work. Literally millions of rivets will be used in the construction of each of these new American dirigibles.

The framework of the ship is composed mainly of a series of transverse rings con-

nected by girders which extend from nose to tail. The rings are in reality 36-sided polygons, though near the tail of the ship the number of sides reduces to 24. At the angles of the rings are connected the longitudinal girders. Main rings are spaced 74 feet apart, separated by the 12 gas cells of the ship. The ZRS-4 will fly when only 10 of its gas cells are filled with helium.

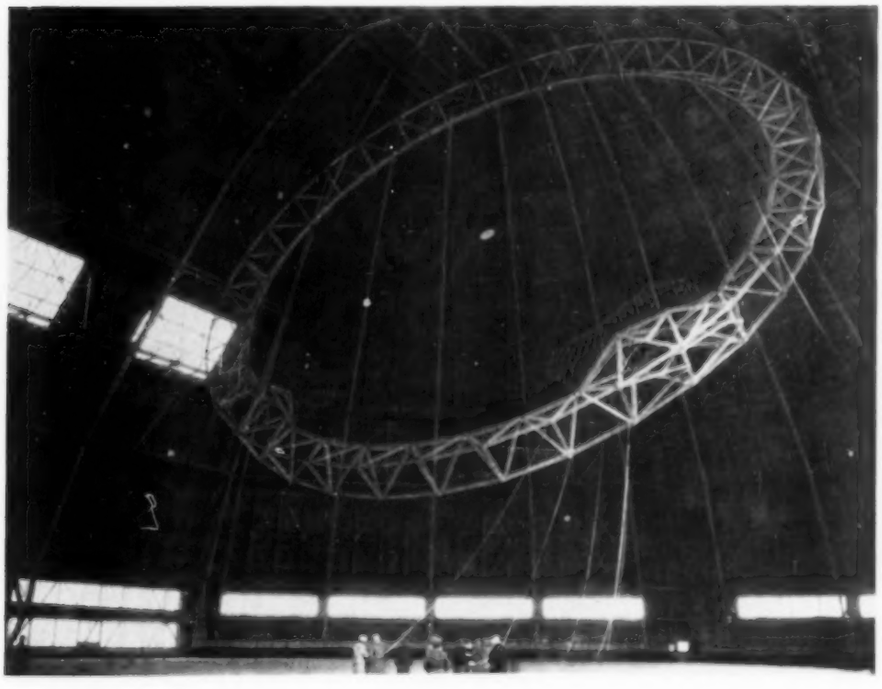
An outstanding feature of the design of the ZRS-4 is the absence of everything unessential to navigation from the outer surface of the ship. A small navigation and control car appears up forward, eight propellers and drive shafts are visible, as are the necessary control surfaces, or fins, at the tail. The ship's eight Maybach engines are located within the hull, each connected to its propeller by a bevel geared drive shaft which permits the propeller to be tilted vertically through 90 deg. The wind resistance is thus decreased while the tilting propellers avoid possible loss of lifting gas when the ship must be landed against surplus lift.

In several respects the ZRS-4 differs from the British ship, R-101, which will soon be launched from the Royal Airship Works at Cardington. The R-100, which made the recent transatlantic trip, is of aluminum alloy construction like the Goodyear Zeppelin, but the R-101 uses stainless steel as well as aluminum in its main frame. Its designers figure that in such a large ship the steel and aluminum construction works out to be lighter than duralumin for a given strength, since the lift of an airship increases as the cube of its linear dimensions, while the weight increases only as the square of those dimensions.

The R-101's main longitudinals are trussed girders of triangular section made of three closed joint tubular booms of stainless with secondary struts of duralumin, and tension diagonals of high strength steel cable. Ridge girders for the rings have open type stainless steel tubular booms with webs of double duralumin sheet punched and flanged like those of the ZRS-4.

Goodyear-Zeppelin Corporation has been allowed 18 months to finish the ZRS-4, which means that the ship must be in the air in May of next year. Twelve months later the ZRS-5 is scheduled to make a trial flight. Construction on the ZRS-4 is at present slightly ahead of schedule.

Hoisting a Main Ring of the ZRS-4. This ring is over 132 ft. in diameter.



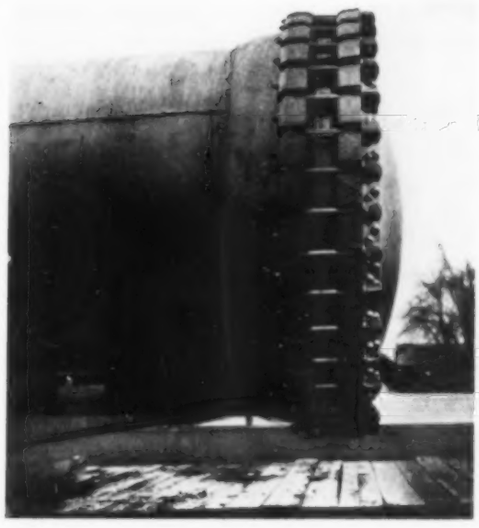
While Fusion Welded Vessels for Low Pressures and Unfired Service Have Been Widely Used, the Boiler Code Has Heretofore Placed Sharp Restrictions on Its Use

Photo by Pictorial Studios (Detroit) at Duro Manufacturing Co., Dayton

Development of Code for

Fusion Welded Boiler Drums

by C. W. Obert



HISTORY of the boiler code movement in America dates from 1905 or 1906, when the first comprehensive code for stationary land boilers was printed and issued by the State of Massachusetts. At about the same time, a like movement started in Canada, in which certain of the Provinces established boiler laws and placed definite codes of rules into effect.

Effort toward a concerted uniformity movement for stationary boilers did not take definite form, however, until 1911, when the Boiler Code Committee was appointed by the American Society of Mechanical Engineers

> "to formulate standard specifications for the construction of steam boilers and other pressure vessels and for their care in service."

At the time the A. S. M. E. Boiler Code was first issued in 1914, there were a number of states and municipalities that had boiler inspection laws and inspection organizations to enforce them, but most of their work was performed without the support and aid of established codes of rules or regulations. All their activities were the result of necessity, the laws having been enacted because of some disastrous boiler accident, and there was little to guide the inspectors other than a few general formulas pertaining to working pressures, stay-bolting, and rivet proportions, which were then common to the several European boiler codes. Each inspector had the opportunity of forming original opinions concerning every construction he examined which embodied unusual features, and it was not surprising that the rulings and requirements of the various States varied to the extent of causing much confusion in the industry.

Restrictions Caused by Repetitive Failures

At that stage in the development of boiler inspection prior to the formulation of uniform codes, all the inspectors seemed to be inclined to be influenced by repetitive failures and accidents. For instance, low-water failures led to drastic restrictions in regard to water-level con-

trol, and the numerous early failures of lap seam boilers, due to cracks adjacent to the lap, were the cause of the narrow limits that now apply for lap riveted seams.

So it was with fusion welding, which also (due to its convenience as a repairing process) began to be quite commonly used in the period between 1905 and 1915 when the boiler code movement was developing. There were a number of failures of welded constructions, due largely to lack of appreciation of the factors required to produce the strong welds that are so necessary in boiler and pressure vessel practice, and the result was that fusion welding at that time was held in disrepute as a mechanical process for the fabrication of boilers.

Welding Now Permissible on Steam Boilers

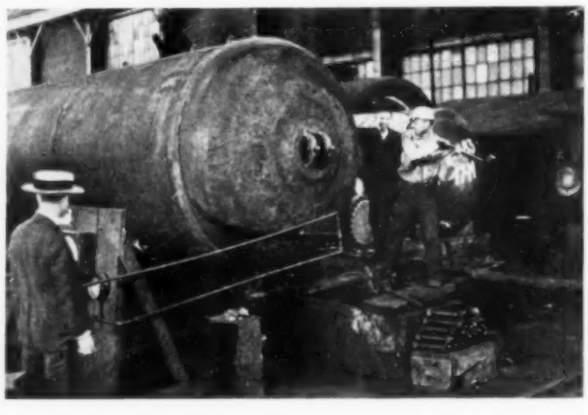
The first edition of the A. S. M. E. Boiler Code (1914) contained nothing that referred definitely to fusion welding. It was at first considered to be inadmissible in any form or for any purpose in boiler construction. As a result of criticisms and petitions for recognition, however, there was incorporated in the 1918 revised edition of the Code the following clause which is now widely consulted and followed:

> "Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code, and where the safety of the structure is not dependent upon the strength of the weld."

Under this provision, fusion welding has been applied to numerous details of boiler construction, particularly where the welded seams may be considered subject to compression rather than tension stress.

These applications embrace such important elements as boiler furnaces of both the staybolted and self-supporting type, in which all joints are considered subject to compressive stresses only. Seal welding of tube ends has been quite extensively practiced in fire tube boilers, particularly in railway locomotive practice. In addition, fusion welding has for some time been used for the attachment of inserted nozzles, threaded outlet flanges, brackets, supports, and other mechanical fastenings to boiler shells for the connection and support of piping, auxiliary apparatus, and structural details. With the extensive revision of paragraph P-186 of the A. S. M. E. Boiler Code in 1929, the welding of turned-in flanges of firedoor and similar openings and flanged-in edges of waterlegs has been permissable. As experience in the application of fusion welding develops, new mechanical applications of welding to boilers are continually found.

Yet as the situation now stands, there are still no established provisions for welded construction of boilers in a broad sense, other than for heating boilers for operation at pressures not exceeding 15 lb. for steam and 160 lb. for water heating, which may of course be wholly welded under the Heating Boiler Code. This was definitely provided for in the second edition of the Heating Boiler Code that was issued in 1922, and since that time thousands of welded steel heating boilers have been produced and welding appears to have largely replaced riveting in this construction. It should be here pointed out that insofar as welded construction is provided for in the Code for heating boiler construction, it is considered for the purpose as the equivalent of riveting for all joints and seams.



It had generally been anticipated that the introduction of welded construction for steam boilers would come in a conservative manner, after it had been thoroughly tried out for unfired pressure vessels. To this end the Boiler Code Committee has recently completed a revision of the welding rules in the Unfired Pressure Vessel Code to the extent of increasing the

size limits for welded vessels from 20 in. to 60 in. diameter, working pressures have been increased from 100 lb. per sq. in. to 200 lb. per sq. in., and the allowable unit working stress from 5600 lb. per sq. in. to 8000 lb. per sq. in. This advance is based on the assurance of good welding offered by the new recommended procedure for fusion welding, which was prepared for the purpose by the American Welding Society.

Extra-Code Requirements of Chemical Industry

While this was an important step in advance in the unfired pressure vessel field, and will provide quite satisfactorily for compressed air

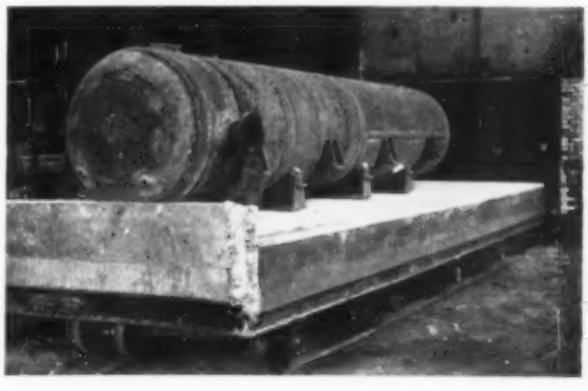
storage tanks and the like, it is obvious that the field of large and heavy vessels for high pressure is still left unprovided for — this in spite of an extensive development during the past five or six years in heavy welded vessel construction for petroleum refining and chemical plants. In the latter, successful results have been obtained in the welding of vessels with wall thicknesses ranging from 2 in. up to as great as 5 in. In these industries, the absence of restrictive legislation has permitted a remarkable development, and the only limits appear to have been what the user seemed to need and was willing to pay for. Both oil refining and chemical process work have turned of late to extremely high pressures, and this has been a strong incentive for such development.

The very natural result of these departures from conventional methods of construction was that they have been closely watched by those interested in high pressure constructions, both boiler and unfired, and in view of their rigorous service records, particularly in oil refining work, insistent demands have come to the Boiler Code Committee to broaden the rules and permit such welded construction.

Particularly has attention turned in this direction as a result of the frequently recurring troubles with boiler drums, so commonly termed "caustic embrittlement". There appears to be a growing opinion that if boiler drums could be welded throughout so as to eliminate the microscopic cracks and seams that exist in riveted joints, the tendency toward concentration of caustic salts therein and attendant embrittlement of the plate would be eliminated. Unfortunately, however, no attempt has as yet been made to experiment with this application of welding under proper working conditions.

Proposed Specifications for Welded Drums Issued

The above considerations and the recent rapid development of higher working pressures and operating temperatures in the steam boiler field have thus changed the situation materially. Both riveted and forge welded construction have proven inadequate for boiler drums or shells to operate at pressures from 900 to 1500 lb. unless the diameters are kept down to impracticable limits. Instead of awaiting its turn in an orderly development, welding of heavy drums has come to be viewed by many as the only solution of the problem, who have urgently requested the Boiler Code Com-



mittee to provide for it in its Power Boiler Code. Several concerns are known to be prepared and ready to weld such shells and drums of practically any size and plate thickness, and accordingly the Committee has been willing to consider proposed specifications for such fusion welding practice when submitted.

Such proposals were received at the September, 1929, meeting of the Boiler Code Committee, and the specifications submitted were given very serious attention. From the results of that meeting, proposed general specifications for welded drums were evolved which were studied jointly with the American Welding Society for several months.

Immediate action was not taken thereon, however, as the subject has been considered to be too important to act upon precipitately. Before further preliminary work was done, it was felt that the Committee should have the benefit of a general discussion by interested parties. The specifications have accordingly been published in the March issues of the American Welding Society *Journal* and in *Mechanical Engineering*, with invitations for general criticism by the public.

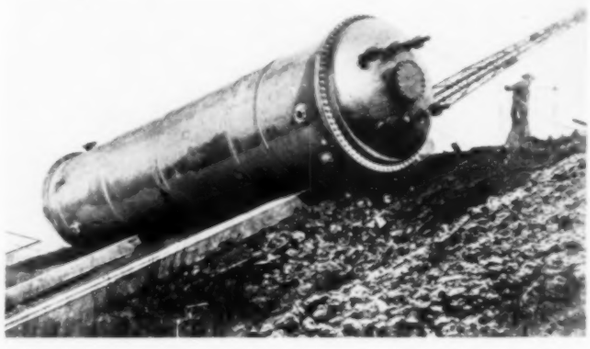
There is one feature of these specifications that is worthy of comment. They constitute an attempt to regulate welded construction by prescribing tests that are to be carried out *after* the structure is completed, and take no detailed account of the process or procedure under which the welding fabrication is carried out. In this they are different from practically all of the previous attempts to codify welded construction, which, due to the difficulty of the problem of non-destructive testing of welds, have been along the line of specifying the details of the process or the method of welding, or in some other manner controlling the welding procedure. Such attempts have their difficulties, and the result is usually indeterminate as far as establishing an actual working stress.

The plan embraced in these proposed specifications is, however, both qualitative and quantitative, and would appear to offer a more definite basis for assigning an actual working stress. There is no doubt but that the testing method of inspection and acceptance of welded boiler drums will have much to commend it.

While it has been customary in the past to base designs on the weakest *known* link in structures, it should always be realized that their safety has always been dependent upon the allowance of a liberal factor of safety to provide in advance for any indeterminate elements that may not have the strength expected. These new specifications for welded drums, on the other hand, promise definite means of predetermining, with considerable certainty, the uniformity of the strength of the entire structure, and are quite likely to direct attention before it leaves the shop to any hidden elements of weakness that might otherwise be overlooked.

Study and Comments Invited

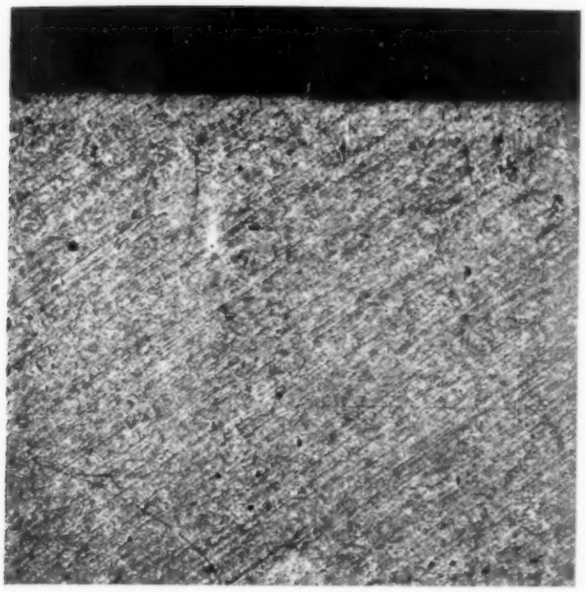
The proposed "Specifications for Fusion Welding of Drums or Shells of Power Boilers"



have been recently submitted to public discussion at symposiums held by the American Welding Society and by the National Board of Boiler and Pressure Vessel Inspectors — the organization of chief boiler inspectors in the various states and municipalities where the A. S. M. E. Codes are enforced. Discussion in both meetings was by speakers who favored fusion welded construction, as well as by those who were conservative in regard thereto, and the record has proven of great value to the Boiler Code Committee.

The latter, in cooperation with the American Welding Society, is now preparing to redraft the proposed specifications. After this is done, it only remains for the Committee to hold public hearings thereon, and then to arrange for final issuance of the specifications as addenda to the Code. It is the expectation that material progress will be made in this direction before the end of the year.

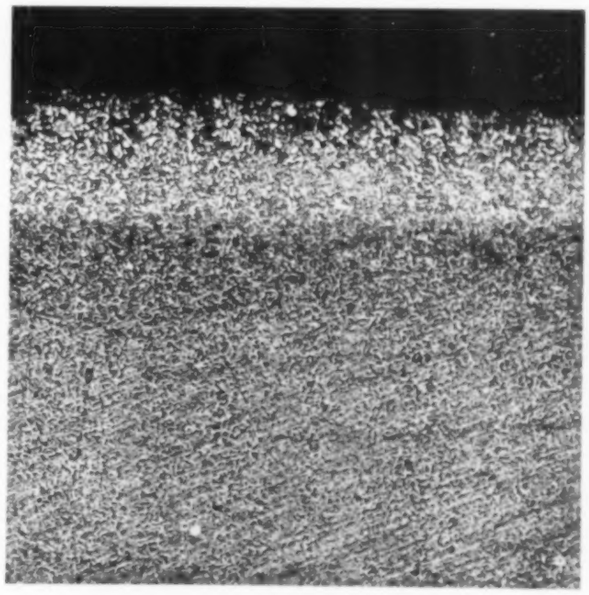
Speeding the Nitride Process



SO SLOW and frequently so erratic is the nitriding process at present that the advantages produced must sometimes be disregarded for economic reasons. The cost of tying up a furnace for many hours may easily overbalance the profits gained from a very hard and corosion resistant material which is not distorted in the process of attaining those qualities. Moreover, the process is not yet wholly dependable and the results do not always come up to expectations.

A. B. Kinzel and J. J. Egan of the Union Carbide & Carbon Research Laboratories, Long Island City, will describe at the National Metal Congress in September a method of shortening the time required for nitriding. (Members of the A. S. S. T. may obtain a complete preprint of this paper by writing National Headquarters, 7016 Euclid Ave., Cleveland, O.) By using suitable packing materials they have succeeded both in cutting down the time in the furnace and in improving the depth and distribution of the case produced.

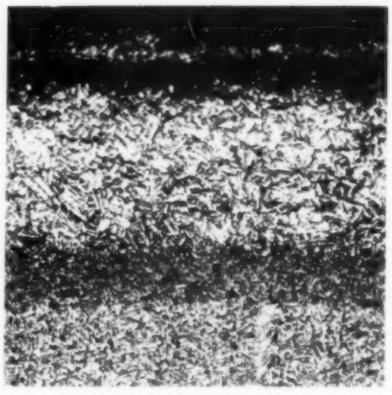
Two steels were used in the experiments. One was a commercial chromium-aluminum steel and the other, previously developed by the authors, a chromium-vanadium steel with a minimum of 0.4 per cent vanadium. A temperature of 460 deg. C. was used for all nitriding, a temperature which ordinarily will not produce a truly hard nitrided case in less than ten hours.



A Chromium-Aluminum Steel was Nitrided 4 Hr. and 50 Hr. in Ammonia at 460 Deg. C. Results are shown on this page at 100 diameters, after etching with Vilella's reagent.

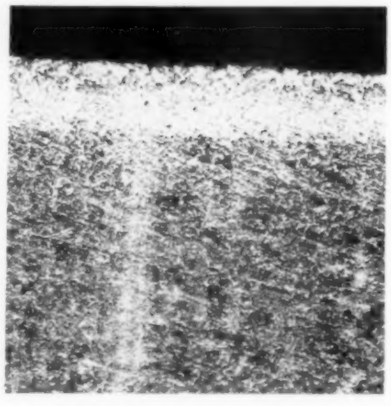
Both nonmetallic and metallic packing materials were used. Magnesia, run through a 275 mesh screen, was the best of the inert materials. The steels under test were completely covered with a light layer of magnesia. Some samples were heated for four hours at 460 deg. C. Other specimens were nitrided under the same conditions for fifty hours. The greater depth of case for a given time is evident upon comparing them with similar steels nitrided without packing. Corrosion tests on the packed specimens show them to be satisfactory in this respect.

Silica flour, lamp black and other inert packing materials were also used successfully, though in every case an insulating effect was noticed which resulted in a longer time being required to bring the specimens up to heat. However, great savings in time *at heat* were effected.



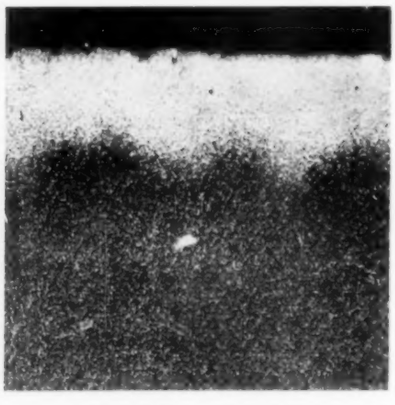
Chromium - Aluminum Steel Sample, Nitrided 50 Hr. in Ammonia at 460 Deg. C. The material was packed in powdered magnesia. Magnification 100X.

It was because of this insulating effect that the authors extended their investigations into the field of metallic packing materials. Copper proved most successful, in the form of fine chips, gauze or filings. More finely divided metal was not used because the insulating effect would have offset any increased usefulness. Brass and aluminum were also tested successfully, but the latter was effective only on the aluminum-bearing steel.



This Sample of Chromium-Aluminum Steel was Nitrided 4 Hr. in Ammonia at 460 Deg. C. It was packed with a thin layer of powdered magnesia. Magnification 100X.

Kinzel and Egan likewise experimented with chips of the chromium - aluminum and chromium - vanadium steels, nitrided for so long that the case extended through the chips. This material was then crushed to a powder and used for packing. Vanadium steel was packed in the nitrided powder of the same material and the aluminum steel was packed in the powdered nitrided chips of aluminum-bearing steel. The results obtained in both cases were almost identical with those obtained by the use of magnesia. Aluminum steel packed with vanadium chips, and vice versa, failed to show any improvement whatsoever. Both steels, however, were satisfactorily nitrided simultaneously when packed in a mixture of equal parts of the two pre-nitrided materials. Chips nitrided at temperatures above 600 deg. C., did not noticeably accelerate the action when crushed and used for packing; chips must be pre-nitrided at temperatures below 580 deg. C.



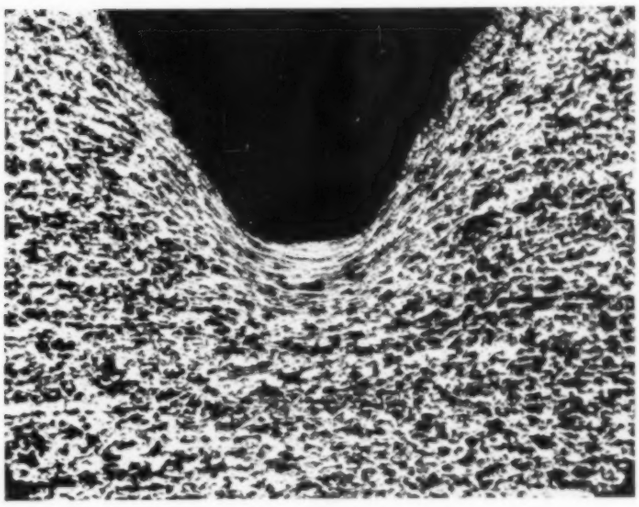
A Specimen of Chromium-Vanadium Steel Nitrided 4 Hr. in Ammonia at 460 Deg. C. A packing of powdered pre-nitrided chromium-vanadium chips surrounded the specimen. Magnification 100X.

Use of packing materials made the nitrided case more uniform in hardness, as well as deeper, in comparison with the same steels nitrided without packing. A specially constructed nitriding box with eight removal vents designed for complete effusion of the gases, when used for unpacked specimens failed to produce a case as uniform, piece to piece, as when the specimens were surrounded by magnesia in an ordinary box with one inlet pipe.

Will a 12,000 pound bolt hold 12,000 pounds?

by H. B. Pulsifer

The Question of Uniformity



Notch Effect of Thread Is More Than Counteracted By Cold Work of Extruding Shank to Pitch Diameter and Cold Rolling the Thread. (Micro at 200X)

PRACTICALLY all bolts and cap screws of the finer grades are bought and sold under some physical specification. The requirement is usually that all the pieces be within some range of Brinell hardness. About 50 units is a common "spread". Brinell 207 to 255 is a common range for treated bolts of straight carbon steels containing 0.30 to 0.40 per cent carbon. Brinell 269 to 321 is a common range for treated bolts containing nickel and of about the same carbon range.

Why this wide spread? Why cannot specifications be written to close the limits which seem to be inevitable in commercial products?

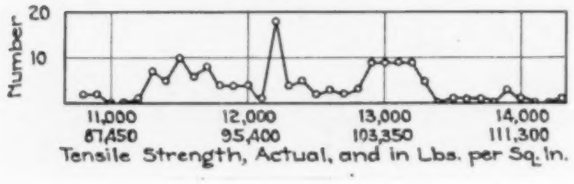
This question is answered by H. B. Pulsifer, metallurgist for Ferry Cap & Set Screw Co., Cleveland, in a paper to be read before the forthcoming National Metal Congress, in which he presents the results of testing a single length of $\frac{3}{4}$-in. bright drawn rod which can be regarded as "uniform", in the ordinary sense of the word.

A thousand scleroscope tests were made in spirals around the wire. The most frequent result was 21. The number of times other numbers were read are plotted in the first curve shown in this abstract of the convention paper. The curve is nearly symmetrical, with many results on both sides but near the most frequent number 21, and a few wide deviations at both

extremes. The average deviation from the most frequent is 1.6 units.

These results are typical of the distribution curves that will be found by numerous tests on any wire, rolled or drawn bar. Thus we find that even in very simple cases the results of many similar tests fall into approximations of the normal or binomial distribution law. This calls for a most frequently occurring number with many others grouped about equally on both sides and diminishing to a few extremes to form the tails of the curve. Neither the mathematicians, the drawers of wire, or the manufacturers of bolts appear able to eliminate the tails of distribution curves.

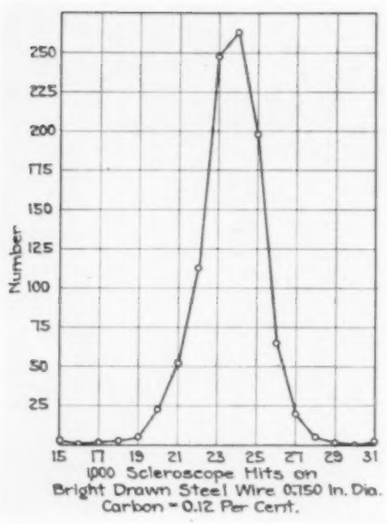
Turning now to tests in regular production, Mr. Pulsifer finds that distribution of test values on the highest grades of bolts approximates this ideal case, whereas astonishing ranges occur when low-carbon bolts are quenched from the critical range, when untreated bolts are made from wire of varying hardness, when medium carbon bolts are carelessly treated or when even alloy bolts are non-uniformly treated in either quench or draw. The second chart shown herewith is a report of tests on 140 "milled-from-bar" bolts that were expected to be uniform in



Cap Screws, 140 of Them, Milled from Bar Inherit the Variations in Properties, Bar to Bar.

properties. Since these are untreated bolts, the cause of the wide ranges is naturally laid to the varying hardness of the drawn bars from which the bolts were milled.

Plotting the results of testing cap screws made in a very simple way from one coil of wire gives the third chart. These cap screws were made by cold up-setting the head. At the same time the end to be threaded was extruded to pitch diameter so that later roll-threading finished the essential processing of the screws. These tests were made on bolts cut off consecutively. Each lot was roll-threaded simultaneously with the same setting of the threader.



A Thousand Scleroscope Tests On a Piece of Bright Drawn Wire Distribute Themselves According to a Normal Probability Curve. Better uniformity could hardly be expected in ordinary practice.

Here is an instance of how a 0.23-per cent carbon steel can be modified by the cold work of the roll-threading process and the strengthening effect of the thread. The chart shows how the most probable value of the tensile strength of this mild steel has been raised to above 100,000 lb. per sq. in.; cold working has not been carried far enough to cause brittleness, since the elongation ranges between 4.7 and 7.8 per cent in 2 in.

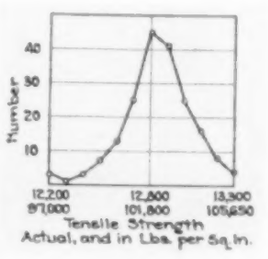
If we now go to heat treated products and confine ourselves to cap screws made from a single coil of wire and treated in one lot we get distribution curves similar to the preceding. The chart shows the results of testing 250 such cap screws made of S.A.E. 1335 steel and treated to the hardness range 207 to 255. The texture of the steel is much finer than the preceding and the properties are correspondingly better.

The narrow range of the tension tests is rather significant. Those who are not familiar with the precision of current heat treatment may be interested in the sharpness of the probability curve.

The heat treated lots were heated for quenching in gas fired retort furnaces of the rotary type. From the retorts the bolts were raked out to slide down a short trough into the

oil quench. Quenching tanks were of the well-known Greene type, the oil being circulated against the bolts with a pump and the bolts caught and elevated in a rotating perforated spiral drum. Bolts were then drawn in electric furnaces of the salt pot or Homo type.

With varying carbon content, such as occurs between different coils of wire held only within commercial ranges, a far greater spread in properties is to be expected. But with the introduction of alloying elements such as nickel, chromium and manganese, it is possible to hold to passably narrow ranges, even with commercial ranges of composition and many coils and many lots in the treatment.

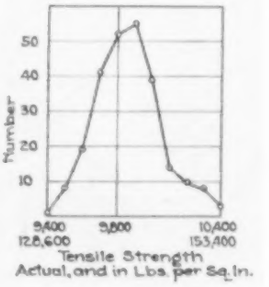


If Well Made Screws from a Single Coil of Wire are Tested, The result Again Shows Good Uniformity.

Data for a variety of bolts and cap screws are assembled in similar distribution charts in Mr. Pulsifer's paper. Results for tensile strength are summarized in the table, containing information not only on the mean tensile strength, but the full spread of values, maximum to minimum (representing the extremes met in commercial production), and the average deviation (representing the ordinary range to be expected.)

Mr. Pulsifer emphasizes that the properties of these bolts (and commercial bolts were tested in every instance) are profoundly affected by the threads, and by the cold working which produces them. Any given material in the form of a threaded bolt will show a greater spread in elastic, yield, and tensile properties than the same material in the form of standard test section. Greater allowance must thus be made in specifying limits.

The curves also show the obvious futility of restricted ranges in hardness, yield point, tensile strength, impact, or other requirement. This futility is only the more delusive if the specifications are taken from charts or tables derived from standard test pieces and indiscriminately applied to bolts. This does not mean that quality will be limited. Rapid progress is being made in developing better bolts. It is well known that the mechanical equipment for the manufacture of bolts is rapidly changing to provide greater speed and accuracy.



Similar Uniformity is Exhibited in Heat Treated Carbon Screws, When Manufacturing Technique is Properly Controlled.

Heating furnaces and quenching tanks are improving even more rapidly. The automatic control of temperature, the circulation of furnace atmospheres and uniform heating and the stirring of the quench are all being perfected.

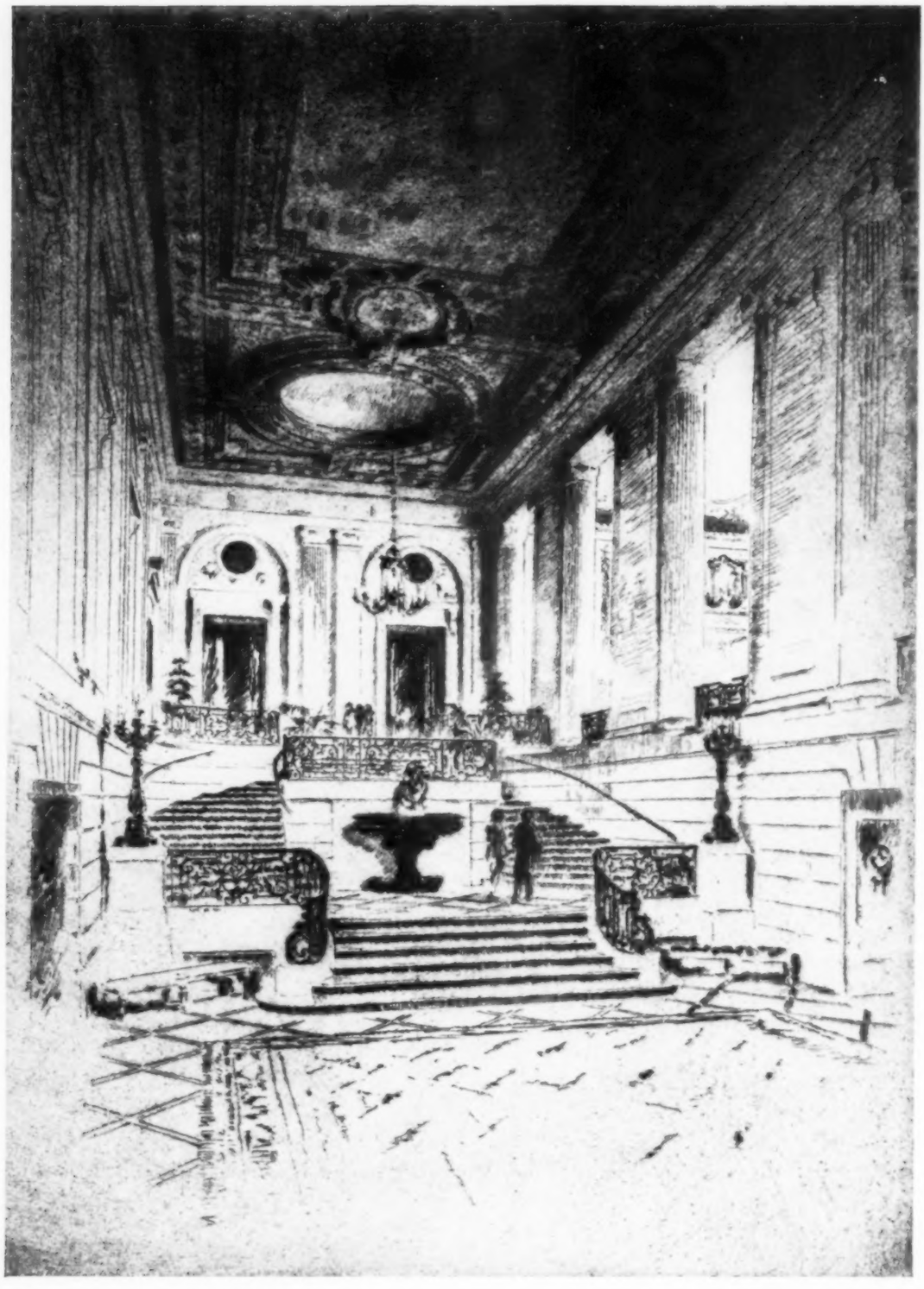
The sampling, analysis and testing of wire, bars and finished product is more frequent and thorough.

It is now known that annealed wire of as high as 0.55 per cent carbon is not difficult to cold head and roll-thread. It may be either simple carbon or alloy stock. The use of the higher carbon ranges allows tensile strengths up to 175,000 lb. per sq. in. in simple carbon steels, and up to or above 200,000 lb. per sq. in. in alloy steels. Even at these strengths and with hardness from 300 to 400 Brinell there may be from 1.5 to 6.0 per cent elongation in the threaded bolt. The S.A.E. 2350 bolts shown on the table with 191,750 mean tensile strength, at 350 Brinell will bend cold through 180 deg. without fissuring.

Accordingly, if finer bolts are needed, they are reasonably sure to be supplied.

PERCENTAGE SPREAD AND DEVIATION OF THE AVERAGE FOR HIGH GRADE BOLTS AND CAP SCREWS

Material	Mean Tensile, in lb. per sq. in.	Full Spread of Tensile, in Per Cent of Mean	Mean Tensile Strength (actual) pounds	Av. Deviation from Mean, pounds	Per Cent Deviation of Average	Method of Manufacture
0.12 C	89,700	10.0	8,000	175	2.2	Extruded and roll-threaded
0.23 C	101,750	8.6	12,800	200	1.6	Do. Do.
0.38 C	125,350	10.6	6,500	150	1.0	Do. Do.
SAE. 1335	146,000	10.1	9,900	200	2.0	Quenched and drawn to Brinell 207 to 255
1.46 Mn	135,700	15.2	9,200	225	2.4	Do. Do. Do. Do.
1.46 Pb	151,900	13.6	10,300	240	2.3	Do. Do. Brinell 255 to 302
0.26 C	132,750	17.8	9,000	252	2.8	Do. Do. Brinell 207 to 255
SAE. 3135	167,000	23.0	13,500	450	3.3	Do. Do. Brinell 269 to 321
SAE. 2350	191,750	12.3	15,300	295	1.9	Heats withdrawn when tests on sample bolts showed a yield point as near as possible to (but not below) 13,100 lb. (actual)
SAE. 2330	137,300	12.6	11,100	375	3.4	Manufactured to minimum tensile strength of 125,000 lb. per sq. in., and cold bend test of 180 deg.
SAE. 1112	98,100	28.3	12,350	700	5.7	Milled from bar.



Up and down the grand staircase of the Hotel Stevens, Chicago, will stroll thousands of business and technical leaders in the metal industries who will attend the National Metal Congress and Exposition, the week of September 22

Metal Men Gather Again

National Metal Congress
Begins September 22

PROGRESS in the production and utilization of metals will not only be discussed by word of mouth but may be visualized in the exhibits which are an essential part of the twelfth annual National Metal Congress and Exposition to be held this month in Chicago. For the first time one building will house all the meetings, the Exposition, and a goodly share of the visitors — Hotel Stevens, the world's largest hotel.

Last year various groups of three other national engineering societies met simultaneously with the American Society for Steel Treating in Cleveland, and found many advantages to accrue to this plan. For instance, a fair proportion of the membership overlaps, consequently one trip to a convention city enabled a man to mingle among friends and contribute to the activities of more than one organization. Furthermore, the diversity of the Exhibition and the programs presented by the cooperating institutions was able to furnish something of keen interest to every engineer who could attend, no matter how specialized his activities.

Indeed, so successful was this cooperation that again in Chicago, starting on Monday, Sept. 22, and continuing until Friday night, the American Welding Society, the American Society of Mechanical Engineers (Iron and Steel Division and Machine Shop Practice Division) and the American Institute of Mining and Metallurgical Engineers (Institute of Metals Division and Iron and Steel Division) will join hands with the American Society for Steel Treating in making the National Metal Congress the outstanding technical event of the autumn months.

Details of the programs for formal sessions have been circulated through appropriate channels to the members of each of these groups, and it is superfluous to repeat them here. Nor is it necessary to list the 175 exhibitors who will occupy the exhibition hall, grand ballroom, lounge and main dining room of the Stevens Hotel, vacated to provide the 80,000 sq. ft. of floor space needed, for only those who have been fortunate enough to participate in former gatherings of this kind can fully appreciate the opportunities which such a congress and exposition will provide.

With the exception of the American Welding Society (which will establish headquarters at the Congress Hotel) all activities of the participating groups will center in the Stevens Hotel, starting with registration early Monday morning, Sept. 22, and closing at 10 P. M., Friday evening, when the gong rings closing the Exposition. Morning and afternoon sessions for the discussion of technical papers will be held daily by the various societies and one is scheduled for Tuesday night by the American Society of Mechanical Engineers. The Exposition will be open from 10 A. M. to 6 P. M. on Monday, Wednesday and Thursday. On Tuesday and Friday the exhibits may be viewed between noon and 10 P. M. Under this arrangement, one more free evening is provided than in previous years.

All technical sessions of the American Society

for Steel Treating will be held in the north ballroom of the Stevens. As mentioned above, the Welding Society will hold its meetings in the Congress Hotel, its headquarters. The south ballroom and the upper and lower tower rooms of the Stevens will hold the other meetings.

In order that a visitor of broad interests may intelligently plan his activities for the week, all meetings are listed below, day by day.

Monday morning the A. S. S. T. will lead off with a presentation of miscellaneous papers on metallurgical topics. Simultaneously, the Iron and Steel Division, A. I. M. M. E., will consider the beneficiation of iron ore — a topic of sufficient importance to occupy the entire day. The Welding Society will get under way Monday afternoon with a consideration of the problem of welded structural steel, during which time the Exposition will be open for pre-view, and the Steel Treaters will be considering various problems related to tool steels and carbide cutting materials.

On Tuesday morning an innovation will be introduced for those in attendance who are salesmen and for manufacturers' representatives from the Exposition. Appearing on the platform will be a typical purchaser who is approached first by a mere order taker and later by a real salesman. That same morning the Institute of Metals will gather for its first session, aluminum alloys being the general topic.

In the afternoon, papers on forging will be read before the A. S. S. T.; the A. W. S. will have a general technical session; both divisions of the A. I. M. M. E. will join to hear papers on theoretical metallurgy, and the Machine Shop Practice Division, (A. S. M. E.) will consider the molding of phenol materials. The latter group is also sponsoring a Tuesday evening session on machine tool motors.

Wednesday morning will bring the annual meeting of the American Society for Steel Treating at which Dr. M. A. Grossmann, of the Republic Steel Corporation, will present the Campbell Memorial Lecture on "Oxygen in Steel." The Welding Society will hold technical meetings at the Congress Hotel both morning and afternoon and the Machine Shop Practice men will be hearing papers on polishing and repairing in the morning at the Stevens. Papers on theoretical metallurgy will be presented at the A. S. S. T. Wednesday afternoon session, while the Machine Shop Practice Division will hear papers on nitriding.

Corrosion resisting metals will be discussed *Thursday morning* before the Steel Treaters. Railroad welding is the topic of the American Welding Society for that time. Iron and Steel Divisions of both the Mining and Mechanical Engineers will have general sessions.

Steel melting is on the A. S. S. T. afternoon program, Thursday. The members of the Institute of Metals will have this afternoon free to visit various Chicago plants, while technical sessions will be held by the Welding Society and the Iron and Steel Division of the American Society of Mechanical Engineers.

The morning of the last day of the Congress will see the members of the American Society for Steel Treating in a session on nitriding, while the Iron and Steel Division, A. S. M. E., will devote their meeting to a study of furnaces. The American Welding Society will have general technical sessions both in the morning and afternoon. Carburizing is scheduled for the A. S. S. T. afternoon meeting, and combustion problems will feature the American Society of Mechanical Engineers' session.

Despite this crowded program, there will be ample time to inspect the exposition, since it will occupy the exhibition hall and adjoining rooms of the Stevens Hotel, where the technical sessions are held. Heavy operating exhibits, machinery, furnaces, welding equipment and the like, will be shown in the great exhibition hall. Lighter displays will be found in nearby ballroom, lounge and main dining room set aside for the National Metal Exposition. The facilities of the hotel have made it possible to arrange a complete and well balanced exhibition of tools and products of the metal industries, and, besides, they will provide an unusually attractive and interesting background.

Both divisions of the Mining Engineers join in a banquet Tuesday night in the south ballroom of the Stevens. The Mechanical Engineers' banquet is Wednesday night in the same room. The annual banquet of the American Society for Steel Treating will be held Thursday night in the north ballroom, and on the same evening the Welding Society will dine at the Congress Hotel.

Die Castings for Economy in Production

By D. L. Colwell

DIE casting is a term often loosely used to mean casting metal in any material other than sand. This would include, for instance, the hand pouring of babbitt into chilled molds, as in lining bearings. It would also include the casting of yellow brass or similar materials in molds made of plaster of Paris. In England the term is often applied to the casting by hand of aluminum into open iron molds, using no pressure other than gravity. It is also loosely applied to slush casting, where soft metals are poured into molds and then poured out again, leaving a hollow skin against the mold surface; and to hot pressing, which is almost a forging operation.

The generally accepted definition of the term in this country, however, has three requirements. First, that the metal must be molten and not in the plastic condition (as in hot pressing). Second, that the die must be permanent and not destroyed each time (as are plaster molds). Third, the applied pressure must be comparatively high, whether applied mechanically or pneumatically.

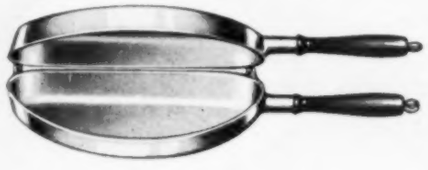
Die casting, therefore, is the process of casting molten metals in permanent dies under comparatively high pressure.

Sizes and Compositions Limited

It is readily seen from the foregoing that the process has its limitations. In the first place, *the size is limited,* as no one has as yet produced a machine which will make castings weighing several hundred pounds each, several hundred times a day. The usual size at present is from a fraction of an ounce up to 8 or 10 lb., although exceptional castings as large as 20 or 25 lb. have been produced.

A second limitation is the shape of the part. Inasmuch as the casting must be ejected from

the die without damage either to the die or casting, there must ordinarily be no undercuts. The taper must always be away from the parting line, and cores must be withdrawn whole. There are several means of getting around this general rule in special cases. Undercuts can often be produced in a casting by the use of inserts, as will be shown in greater detail later. Collapsible cores have been made which allow a cored hole to be larger at the far end than at the surface. This also has been done by the use of fusible cores which are cast in place as inserts and then melted out. Other engineering wrinkles have also been used, but inasmuch as these ideas are usually comparatively expensive, they are exceptions rather than the rule that no undercuts are allowable.



Material is one of the greatest limitations of the die castings process. Only metals with melting points below approximately 1400 deg. Fahr. have been successfully die cast. This necessarily eliminates iron (and steel castings are often necessary for strength), copper or its alloys (where strength or electrical conductivity is necessary), and nickel or other alloys of high melting point for certain special properties they possess. The alloys which are now successfully die cast are based on either tin, lead, zinc or aluminum.

Price is another limiting factor. Piece for piece a die casting is usually more expensive than the same part stamped, forged, or cast in sand. They find their great field, however, wherever they effect a saving in other operations. For instance, one die cast part often replaces several stampings and consequently eliminates an expensive assembly operation. The accuracy of a die cast part very often eliminates several expensive machining operations, when the machined casting becomes more expensive in the end than the die cast part. In the same way polishing operations on a die casting often save more than enough to pay for the increased cost of the casting, since its finish is so much superior to that of the usual sand casting. In estimating, therefore, whether or not it would pay to die cast a certain part, the decision must be based, not on the comparative costs of securing the casting alone, but upon total cost of the whole product.

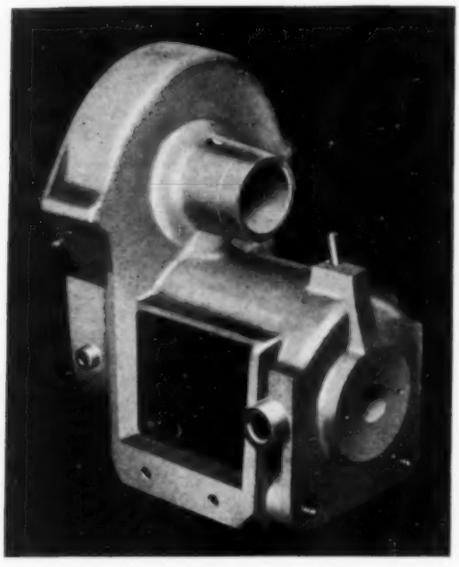
Another limiting factor is that of quantity. Since the production requires expensive dies, it is necessary for that production to be large enough to pay for these dies. No fixed rule can be given for determining how large these quantities must be, as they vary greatly in individual cases. There have been instances where the collateral savings on a few hundred castings more than paid for the die, but in other cases it has taken several thousands. This is another point which must be carefully investigated before deciding either for or against the application of die castings.

Lead and Tin Alloys First Used

As stated before, the four classes of materials commonly die cast are alloys of lead, tin, zinc and aluminum respectively. The lead base alloys are perhaps the simplest. They consist either of pure lead, of lead alloyed with as much as 20 per cent antimony, and of lead alloyed with both tin and antimony. For specialties, copper, bismuth, or cadmium may also be added. A typical analysis is S.A.E. specification No. 14, which is 75 per cent lead, 10 per cent tin and 15 per cent antimony.

Lead alloys made the original die castings. Lead resists almost any kind of corrosion and its die casting alloys melt from about 460 to 620 deg. Fahr. They are heavy, their specific gravity running from 9.6 to 11.4, which means about ⅜ lb. per cu. in. They are soft (unless enough antimony is added to make them brittle); the Brinell hardness is from 10 to 30. Their tensile strength varies from about 4000 to 16,000 lb. per sq. in., and their strength in compression from about 10,000 to 20,000 lb. per sq. in.

Lead die castings are used for light duty bearings and for parts which must withstand corrosion, such as pump impellers. Their value for bearings is somewhat under-estimated. Most engineers prefer a "genuine" bab-



bitt, which is principally tin hardened with antimony, and is much more expensive than a lead base bearing metal, but in a great many cases the cheaper one would do the work just as well. Lead die castings should not be used where they may come in contact with food, as there is some danger of lead poisoning.

Tin base alloys are also very simple to cast. Their compositions also vary considerably. A typical analysis is S.A.E. No. 11, which consists of 87½ per cent tin, 6¾ per cent antimony, and 5¾ per cent copper. Lead is often added to tin base alloys to save the higher priced tin. It softens and weakens the alloy, especially at moderately elevated temperature.

Tin base alloys, because of the high price of tin, are used only for certain special purposes. Like lead, they resist corrosion very well, and they do not form poisonous salts in contact with food. Their melting point is usually the lowest of all die casting alloys, ranging from 360 to 770 deg. Fahr. The specific gravity ranges from 7.3 to 8.3, depending on the lead content. This is about 0.25 to 0.3 lb. per cu. in. They are also soft, with Brinell hardness of 19 to 30, but are tougher than the lead base alloys. Their tensile strength varies from 13,000 to 18,000 lb. per sq. in., and their compressive strength from 12,000 to 20,000 lb. per sq. in.

They have two principle uses, namely, in high grade bearings and in food container parts. These alloys consist of a matrix of soft tin held together by needle like pieces of a copper-tin constituent, with hard cubes of an antimony-tin constituent embedded. This makes an excellent bearing structure.

Their resistance to corrosion is the principle reason for using them in food container parts. A particular application is in syrup pumps and carbonated water heads in soft drink fountains.

Zinc and Aluminum Alloys Now Most Important

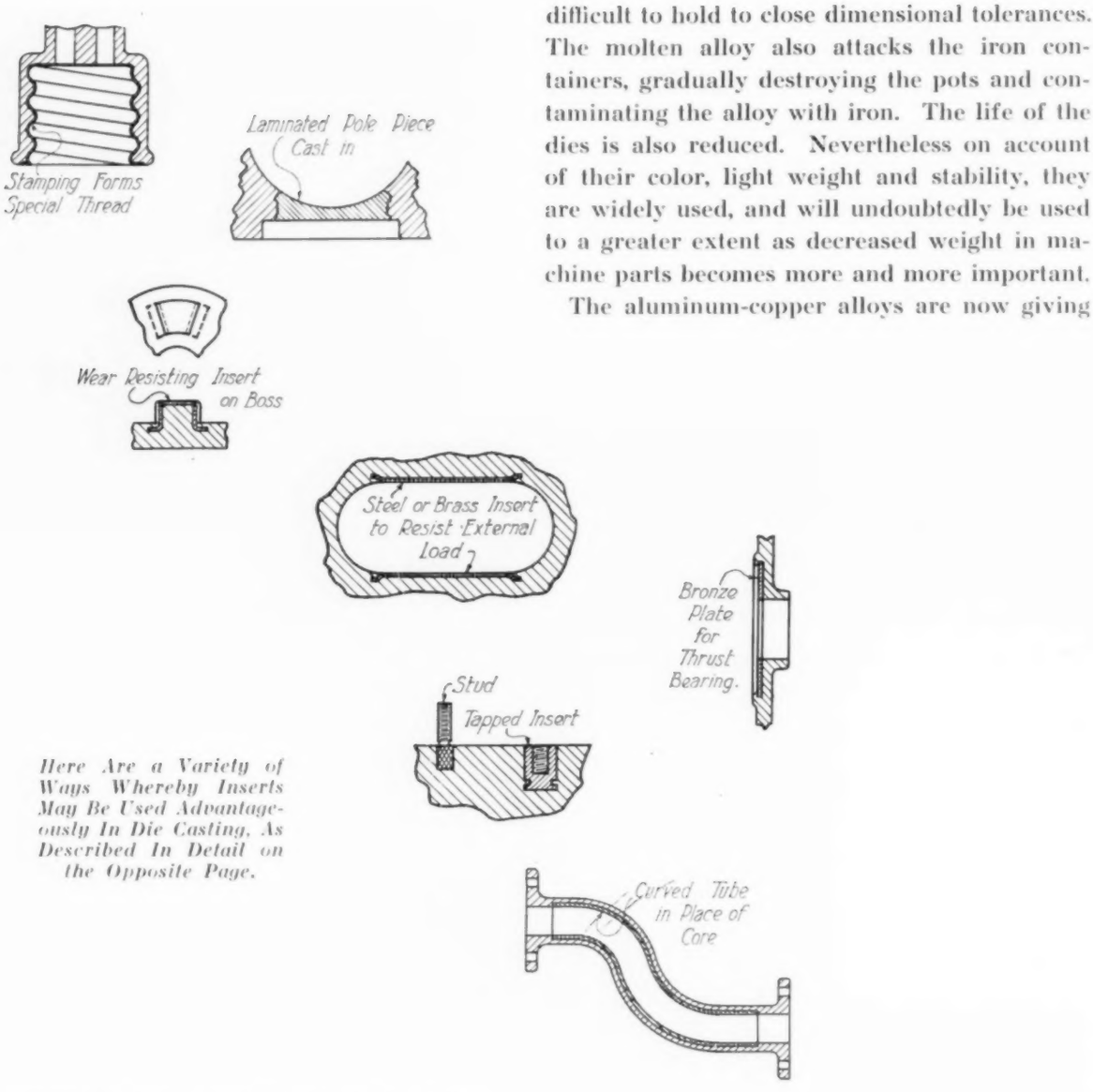
Zinc base alloys are now cast in the greatest tonnage at present, although the number of castings made of aluminum base alloys is probably equal to the number of zinc base alloys. In fact, these two classes of alloys now dominate the business, and their importance warrants the enormous amount of investigative work which has been lavished upon them by producers and consumers, both in America and in England. A separate article will be needed to give even an outline of the information at present available.

In general, zinc base alloys are highly desirable for their low melting points (approximately 750 deg. Fahr.) and are not severe on the machine or die materials. They are fluid and cast easily; some of the newly developed compositions are especially tough at temperatures just below the freezing point. They are therefore the cheapest of all die castings per piece.

When these alloys were first introduced it was unfortunately not known that minute amounts of certain metals cause the castings to swell, warp and crack, especially in humid atmospheres. Consequently, many people still erroneously believe that all die castings will behave the same way. As a matter of fact, researches by the New Jersey Zinc Co. and by the British National Physical Laboratory have shown that zinc base die castings are quite stable when these contaminating impurities are rigorously excluded from the alloy. These conclusions are also being verified by extensive work under the direction of the American Society for Testing Materials.

difficult to hold to close dimensional tolerances. The molten alloy also attacks the iron containers, gradually destroying the pots and contaminating the alloy with iron. The life of the dies is also reduced. Nevertheless on account of their color, light weight and stability, they are widely used, and will undoubtedly be used to a greater extent as decreased weight in machine parts becomes more and more important.

The aluminum-copper alloys are now giving


Stamping Forms Special Thread
Laminated Pole Piece Cast in
Wear Resisting Insert on Boss
Steel or Brass Insert to Resist External Load
Bronze Plate for Thrust Bearing.
Stud
Tapped Insert
Curved Tube in Place of Core
Large Undercut Made With Two Steel Stampings
Bronze Bushing
Steel Pivot Cast in

Here Are a Variety of Ways Whereby Inserts May Be Used Advantageously In Die Casting, As Described In Detail on the Opposite Page.

Two general classes furnish the bulk of the zinc base die castings. One contains 90.5 per cent zinc, 3 per cent copper, 6 per cent tin, and 0.5 per cent aluminum. Alloys of this analysis are not very strong, and are used in places where ease in soldering is a prime consideration. Engineers generally prefer the following: 93 per cent high grade zinc, 3 per cent copper, 4 per cent aluminum, 0.1 per cent magnesium. Physical tests of die cast test bars made of such an analysis show the following:

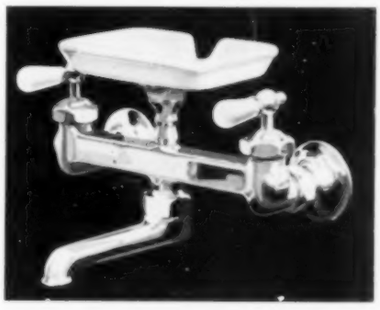
Ultimate tensile strength, 45,000 lb. per sq. in.
Elongation in 2 in., 1.5 per cent
Brinell hardness, 90
Charpy impact, 3.0 ft.-lb.

Aluminum base die castings, because of the higher melting point of the alloys, are more

way to the aluminum-silicon alloys (with or without a little copper) and the aluminum-silicon-copper-nickel alloys. The latter alloys are generally easiest to machine and polish, although they are expensive in raw metal cost and have definite casting limitations.

The physical properties of die cast test bars, while they naturally vary for the different chemical analyses, are of the following order:

Ultimate tensile strength, 30,000 lb. per sq. in.
Elongation in 2 in., 2.5 per cent
Brinell hardness, 60
Charpy impact, 3 ft.-lb.



Complex Parts Made by Using Inserts

The use of inserts in the die casting process has not only frequently improved the quality of the casting, but has often secured business in parts formerly made by more complicated production methods. Inserts provide the necessary increased strength and wearing stamina that enable die castings to be used for parts subject to severe shock and strain. They give added resistance to points of stress; they allow axles and pivots, magnetic poles and screw threads to be cast in place. While nothing in the scope of die-casting engineering demands more expert craftsmanship than the application of inserts, when properly used they are highly advantageous. When used unwisely they increase the unit cost of the casting and retard the operation. Inserts such as sketched in the diagram may be used to provide

(a) Greater strength for points of stress

(b) Increased hardness for localized points

(c) Special electrical properties at localized points

(d) A means of lubrication to inaccessible points

(e) Better friction qualities at localized points

(f) Soldering or brazing on castings made from alloys (such as aluminum alloys) which ordinarily cannot undergo these treatments

(g) Reduced assembly and handling costs.

One variation of a method for making large undercuts is sketched. A shell is made of two simple thin stampings and used as an insert. A wide range of variously shaped parts can be made in this way that otherwise could not be handled by the die casting process.

A piece of tubing is used when a long curved hole is required. This idea is often used for an oil feed line to a bearing; the tube is then embedded in the wall of the casting. Tubing inserts are sometimes used to carry through the casting liquids or gases that otherwise would affect the casting itself. In other cases tubing is used as an insert where extremely high air pressure is carried.

Threads to fit a glass bottle top may be made of a thin sheet metal insert with a rolled thread. Ordinarly an internal thread of this form can be made a part of the casting, but in this casting a threaded core could not be turned for withdrawal.

Means for anchoring inserts should be provided except in cases where the shape of the insert itself prevents loosening. All that is necessary is knurling, grooving or upsetting. Sometimes flat inserts are anchored by means of countersunk holes that become filled with molten alloy and hold the insert firmly in place.

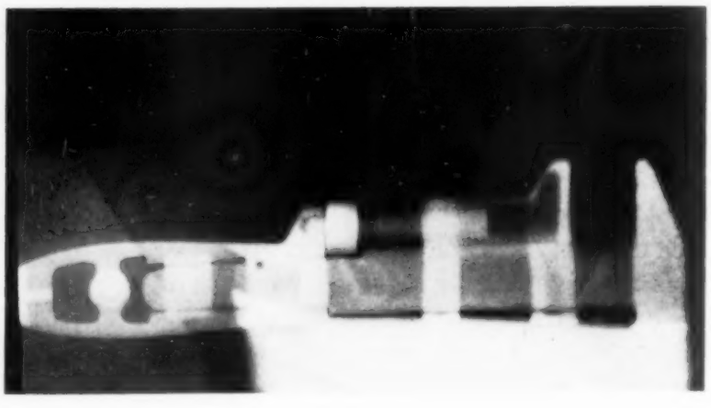
A good example of the use of inserts is illustrated in the aluminum magneto housing shown on page 93 which contains ten inserts. Six of them are threaded brass studs, cast in place. Two soft iron pole pieces are also cast in place, as are a copper tube for oiling the bearings and a brass ring for a bearing retainer.

Quantity production of such a part to the accuracy afforded by the die casting process could not be obtained in any other way, and in general reflects the high quality of work which consumers of die castings can expect from the American industry today.

* * *

Mr. Colwell's address included a discussion of the properties and utility of the zinc base die castings and also of the aluminum base die castings. These most important matters will be covered in a second installment of this article, to be published later.

Exploring A Metal's Insides With Radium



This Wrench was Six Feet Away From the Emanation, Hence the Sharp Definition.

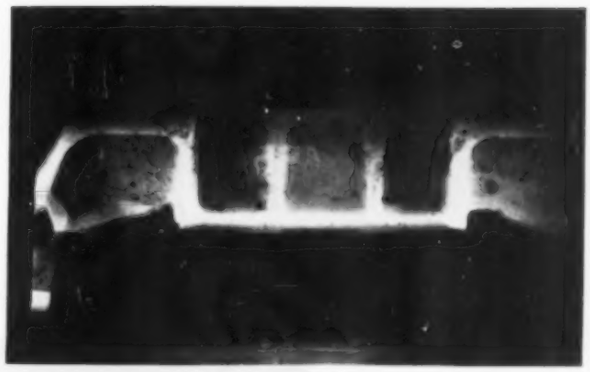
PHYSICAL testing has always depended on the assumption that a lot of the material is sufficiently uniform in quality that a small sample (which can be tested to destruction) will be representative of the whole. Generally, this assumption is warranted, when the product is the result of carefully controlled operations and is free from visible external defects. But in some instances, in structures or parts of unusual importance, it is very desirable that the ordinary methods of inspection be supplemented by some non-destructive test which will insure the internal soundness of each individual piece or portion of the whole.

Electric and magnetic devices offer possibilities for such internal inspection when the material has a relatively uniform cross section, like wire, cable, chain, or rails. X-rays are also being used to a considerable extent to locate small but trouble-making interior flaws. The latter equipment is able to explore castings and forgings of irregular shape, and of ordinary size, but the penetrating power of the rays limits the application of ordinary equipment to about four inches of steel.

Even this limitation may be removed by the use of the so-called gamma rays from radium, according to Robert F. Mehl, superintendent of the division of physical metallurgy at the Naval Research Laboratories in Washington, in a paper to be read before the forthcoming National Metal Congress in Chicago. These gamma rays can penetrate 10-in. sections of metal because their wave length is much shorter than that of X-rays.

Mehl's gamma rays were obtained from radium emanation ("radon", so-called by the doctors), a chemically inert gas which is the first product in the decomposition of radium. In medical practice the emanation is pumped from a solution of the radium salt, and condensed from the gases with which it is mixed by liquid air. Each gram of radium furnishes 0.06 cubic millimeters of gas per day. It is accumulated by pumping the daily "make" into small glass capsules encased in brass. The emanation gains maximum radiating intensity within a few hours which then decreases until in four days it is only half the maximum.

Its Gamma Ray Photograph.



The Casting.

Its X-ray Photograph.

The strength of the emanation is measured in millicuries, units which represent the radiating strength of one milligram of radium which forms emanation as fast as the emanation can decompose. By pumping off the emanation daily 150 millicuries can be recovered by a skilled operator from one gram of radium. A permanent stock of emanation with a total strength of 800 or 900 millicuries, ample for radiographic purposes, can thus be accumulated, the difference between the actual stock and the 1000 millicurie theoretical maximum being due to unavoidable losses during manipulation.

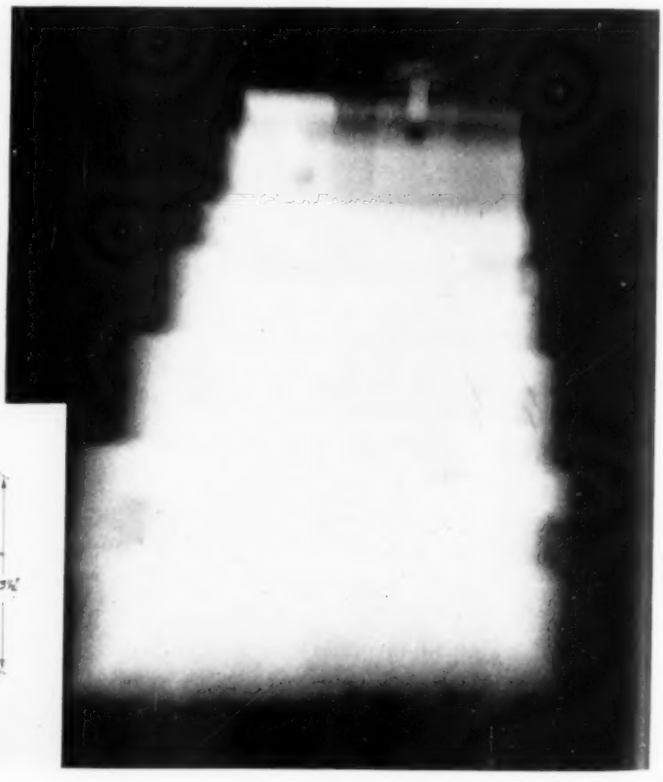
Gamma ray radiography does not require the operator's presence during the exposure time. No high voltage equipment is needed but because the emission of gamma rays cannot be controlled it is advisable to make as continuous use of the source as possible. The operator must of course be protected against gamma rays as well as X-rays, but there is no better protection than distance, and this protection can

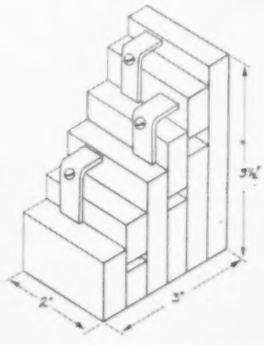
Radiography by gamma rays needs only simple apparatus. The thistle tube rising from the center of the table holds the capsule of emanation. Specimens can be set around it in any plane because the rays travel spherically in every direction. Specimens are mounted on stands, the film holder adjusted behind them and the capsule dropped in the thistle tube. Films and developing procedure are similar to those used in X-ray work.

easily be obtained when taking radiographs by gamma rays. The emanation itself is usually carried in a small thick walled lead box and is handled by forceps. Medical men say that the technique described by Mehl eliminates the possibility of harm to the operator.

As shown by the views the method is simple in the extreme. The part to be studied is properly mounted at a convenient distance and angle from the radon, (for the radiation spreads out like a sphere, equal in intensity in every direction). A photographic film or plate, in a light-tight holder, is placed behind the object, and at right angles to the radius from the center. Leave this set-up undisturbed for sufficient time, and then develop the plate.

It does not matter if the exposure is interrupted by taking the radon away temporarily for other uses. For that reason the methods described by Mehl are best practiced as a by-product of the work at some hospital. When the radon is not in use for therapeutic purposes, it may as well be in the thistle tube, working as a metallurgical inspector, as a prisoner in a strong safe—for it keeps on radiating wherever it is.





A sketch and a gamma ray radiograph of an echelon of steel plates. The specimen was placed 6 in. from a capsule of 179 millicuries of emanation and exposed for 25 min. The screws and angles, which held the plates together can easily be seen, as well as the slots indicated in the sketch.

Correspondence and Foreign Letters

Doctor Honda's Institute Enlarges Its Activities

EXPANSION of activities at the research Institute for Iron, Steel and Other Metals, Sendai, Japan, was planned for the third time in 1928. New work is to be chiefly a study of titaniferous magnetic sand (a large quantity of which, amounting to several billion tons, is found in northern parts of Japan) and also to study light alloys. For this purpose the Institute received last year from the Government a temporary grant of 58,000 yen for the building extension, and 20,000 yen for equipment. From the present year, the annual budget has been increased by 60,000 yen, so that our annual income now amounts to 230,000 yen. These investigations of titaniferous magnetic sand as an iron-making ore and of light alloys, especially of magnesium alloys, have already been started.

An interesting study of the effect of cold-working on Young's modulus of elasticity has been published by Tadashi Kawai in Science Reports for 1930, page 209. The author measured the change of the modulus caused by cold-working in iron, steel, nickel, copper and aluminum. In the case of iron and steel, which have a body-centered cubic lattice, the modulus of elasticity is decreased by cold-working at first rapidly and then more slowly as the degree of cold-working increases, tending to an asymptotic value. In the case of nickel, copper and aluminum, which have a face-centered cubic lattice, the modulus of elasticity is first decreased till a minimum is reached, and then begins to increase.

Mr. Kawai attributed the above change of elasticity to the combined effect of two mutually opposing factors; that is, (1) internal stress, which is set up within metals by cold-working, and which effect has already been predicted theoretically by the writer (Sci. Rep. 17, 1928, p. 723) to diminish the modulus of elasticity, and (2) the rotation of a certain axis of the micro-crystals in the direction of stretching or drawing, thereby increasing the modulus of elasticity.

Generally, crystals have different values of elasticity for different crystallographic axes. In the case of iron and steel, the (110) axis is turned in the direction of stretching or drawing, and the modulus of elasticity in this direction is a little greater than the mean of those in the other directions, but in the case of nickel, copper and aluminum, the (111) axis is brought into coincidence with that of stretching or drawing, and the modulus in this direction is greater than those in other directions. Hence the second increasing effect is rather small in iron and steel, and is considerably larger in other metals, so that in the latter case, the modulus of elasticity first decreases and afterwards increases as the degree of cold-working increases.

That remarkable alloy, invar, discovered by Guillaume, has a small expansion coefficient, of the order 1×10^{-6}, which is somewhat larger than that of fused quartz. Assistant professor H. Masumoto in our Institute discovered a new invar last year, whose coefficient of expansion is much smaller than that of fused quartz, being of the order 1×10^{-8}. Early in 1930 we heard that a similar alloy having the coefficient of expansion of an order 5×10^{-7} had been found by H. Scott in the Westinghouse laboratory, East Pittsburgh.

K. Honda,
Sendai, Japan.

Organization of Metallurgical Research in Sweden

TWO OR THREE centuries ago Sweden was both quantitatively and qualitatively the leader among the iron producing countries of the world. Because of its almost complete lack of mineral coal it long ago gave up this dominating position as far as the tonnage of output is concerned. In respect to the quality of its steel it is, however, still keeping up its position in the first rank.

In Sweden, as in other countries, it has been generally realized that a high qualitative standard can now be safely maintained only if production is based upon scientific control. The

need of metallurgical research has of late been distinctly recognized not only by the iron makers of Sweden but also by the representatives of the nonferrous metal industry. For that reason the Institute of Metallography was started in Stockholm ten years ago and put under the leadership of Prof. Carl Benedicks.

This step was not, however, considered to be sufficient. Quite recently Jernkontoret, the Iron Masters Association, a venerable institution, founded in 1747, has organized a special research council, thus again, as often before, contributing to the advancement of metallurgy. Axel Wahlberg is now president of Jernkontoret and Prof. Arvid Johansson was made head of its research council.

This council consists of technical representatives of the steel works and a few other metallurgists. It is divided into four sections for the following special purposes: I. Mining, II. Production of pig iron, III. Production of steel, IV. Working, heat treatment and testing of steel. The council has no research institute of its own. Its main task is to decide which of the suggested research problems ought to be attacked, to distribute those selected among the different laboratories of the industry, the Institute of Metallography or the research laboratories of the technical colleges and universities, and finally to grant the sums necessary for carrying out the projected investigations. The work of the council is to a large extent financed by special contributions from the various steel plants. The head of the council has a rather difficult task to follow and control this comprehensive and wide-spread research activity.

It will be interesting to observe how this organization will work, since it is not quite certain that quasi-parliamentary methods will prove more efficient when applied to scientific investigations than they are in political life. At any rate, the iron makers will become more accustomed to cooperation — that itself is most valuable, as united work may be considered quite necessary, if the Swedish iron industry is to keep its position in international trade.

At the invitation of Jernkontoret Dr. W. Rosenhain at its spring meeting this year delivered a discourse on "Research and Industry". The opinion on this subject, put forth by him at that occasion, is certainly well-founded and judicious and ought to be shared by all who are interested in the development of technical culture. His lecture will soon be published in Jernkontorets *Annaler*.

A. Westgren,
Stockholm, Sweden.

A Flexible Knife Blade

I RECENTLY purchased a knife which will carry an edge like a razor but is so ductile it can be bent or twisted, and then straightened without breaking or spoiling the steel. While this may be thought to be something of a curiosity, if it could be regularly produced commercially it ought to have considerable use in making irregular shaped knife dies for cutting rubber sheets or leather.

It would seem that the ability to retain a keen edge (hardness) and the ability to be bent (ductility) are mutually conflicting properties. In other words, a keen edge, in order to remain keen while doing some useful work, must be made of metal which is stiff enough so that the backing of the edge will prevent it bending over, "feathering," or blunting.

Some time ago a friend showed me a pocket knife with stellite blades which acted something like the one now in my possession. I am told that the Haynes Stellite Co. formerly paid much attention to the manufacture of cutlery and surgical and dental instruments, but that this minor outlet was abandoned for metal cutting tools, which absorb a far greater poundage of the alloy. Also that the stellite alloys, being essentially of cobalt, chromium and tungsten, are inherently hard — that is, the hardness does not necessarily depend upon a definite heat treatment, such as induces the hardness to the carbon steels. Whether some of the stellite alloys are hard and at the same time ductile would appear probable, but I still cannot see how such a metal could retain a good cutting edge when working against any moderately hard wood.

This knife in my possession will cut through Douglas fir, ¾-in. square, across the grain, at less than 30-deg. angle with very little effort, and retain its edge. The blade is marked "Morakniven," and I find is distributed by Sandvik Canadian, Ltd. of Montreal. *Cont. on page 102*

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Its blade is 1 in. by 4¼ in. long, well mounted, and sells on the Coast for 75c, so I am sure it is not a complex alloy. The back of the blade can easily be touched with a file. Perhaps the explanation is that only the cutting edge has been case-hardened, or that it is forged from a strip of duplex steel — back soft, edge hard.

A. H. Alexander,
Victoria, B. C.

Importance of Clean Steel in the Ingot

THE TWO BRITISH metallurgical societies will hold their Autumn Meetings in September, the Institute of Metals meeting at Southampton, while the members of the Iron and Steel Institute will go so far afield as Prague, visiting some of the steel works of Czecho-Slovakia after the reading of the papers. Both institutes have an interesting program, which will be discussed in due course.

In the meantime, attention may be called to a communication by Dr. W. H. Hatfield to the Institution of Automobile Engineers, recently published with discussion. The author gives a very full survey of the question of steels to be used in automobile construction, and presses for a further degree of standardization. He enumerates no less than 18 types of steel in use for structural parts, and 9 valve steels.

Much difference of opinion exists regarding the desirability of using alloy steels in place of plain carbon steels. Price is frequently the determining factor, but when a comparison is made between ordinary automobile practice and that of the aero engineer, the saving of weight brought about by using carefully chosen alloy steels, correctly heat treated, is remarkable. When it is stated that aero engines have been made with a weight of ½ lb. per h.p., while the automobile engine weighs 11 to 13 lb. per h.p., the metallurgist is given something to think about.

Dr. Hatfield's paper concludes with an appendix in which 133 different parts are arranged in tabular form, the nature of the stresses being indicated in each case, with notes of the type of steel suggested for each part in (a) aero engines, (b) racing and touring cars, and (c) slow-moving vehicles.

Reference is made in the paper to the necessity for studying the production of the ingot from which an engineering steel is made. The author is known to have a strong preference for steel made in the electric furnace over open-hearth steel, and he also calls attention to the work of the Ingots Committee of the Iron and Steel Institute which has already issued three reports.

The Committee has now sectioned, analyzed, sulphur-printed and etched a very large number of ingots, and last winter it undertook the production of a series of experimental ingots weighting 38 cwt. each in the open-hearth plant of Sheffield University. The account of these will form an important part of the next report.

Two other committees have extensive programs of work in hand, that on the corrosion of iron and steel, and that for the investigation of steels and other alloys capable of resisting high temperatures. This is a field in which very great progress has been made quite recently, and alloys offering a quite remarkable degree of resistance, both to scaling and to creep at high temperatures are now available.

An interesting feature of steel manufacture in this country is the increasing popularity of the high-frequency induction furnace for the production of the higher classes of steel. Although the scale of such furnaces is still comparatively small, (500 to 600 lb. capacity, now being increased to 2000 lb.), it suffices for the more costly alloy steels, and the perfect cleanliness of their operation is of such great advantage that we may look forward to a considerable growth of this method of heating.

Those who had experience with the early small Ajax-Northrup furnaces have watched with satisfaction the development of the principle. A much lower frequency than was at first thought necessary has proved to be sufficient, and the difficulties of construction are being ingeniously overcome.

C. H. Desch,
Sheffield, England.

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Recommended Practice Committee Releases

Constitution of Copper-Tin Alloys

By Samuel L. Hoyt

THE copper-tin alloys were among the first to be studied experimentally and their historical significance gives them a special place in our list of metallic alloys. The first systematic investigations were those of Roberts-Austen, Stansfield, and Campbell in their classical work for the Alloys Research Committee of the Institution of Mechanical Engineers. This was immediately followed by the diagram of Heycock and Neville who applied the principles of the phase rule to this system with the same success that attended similar work on the iron-carbon alloys by Roozeboom. It was this work on the iron-carbon and copper-tin alloys that organized our understanding of constitutional changes in alloys and gave the correct guide to experimental work in this field. Shepherd and Blough, in this country, and Giolitti and Tavanti in Italy soon followed with their contribution while, a little later, the writer was able to show that certain modifications of the original diagram were necessary. Soon after the war, work on this system was again taken up, and as a result we have the work of Corey, in Professor Campbell's laboratory, and of various English, German, and Japanese investigators. The result of this work gives us a copper-tin diagram that while it is very satisfactory from the practical standpoint, leave some controversial features regarding the interpretation of the experimental facts.

The copper-rich portion of the copper-tin constitution diagram is reproduced herewith. This is the diagram as given by Heycock and Neville[1] in their classical paper on this system and is based mainly on the melting point determinations of Stansfield and Roberts-Austen[2] and the microscopical examination of heat treated samples for the determinations of the fields within the solid state. The main features of the constitution of this system were well established by this work, although later work has modified the diagram somewhat and has introduced some controversial features. *(Continued page 106)*

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Copper-Tin Alloys (*cont'd*)

The more important constitutional features of this system may be listed as follows:

(1) Tin lowers the melting point rather rapidly from 1083 degrees Cent. for pure copper to 795 ± 5 degrees Cent. at 25 per cent tin. Above 25 per cent the effect of tin is less pronounced.

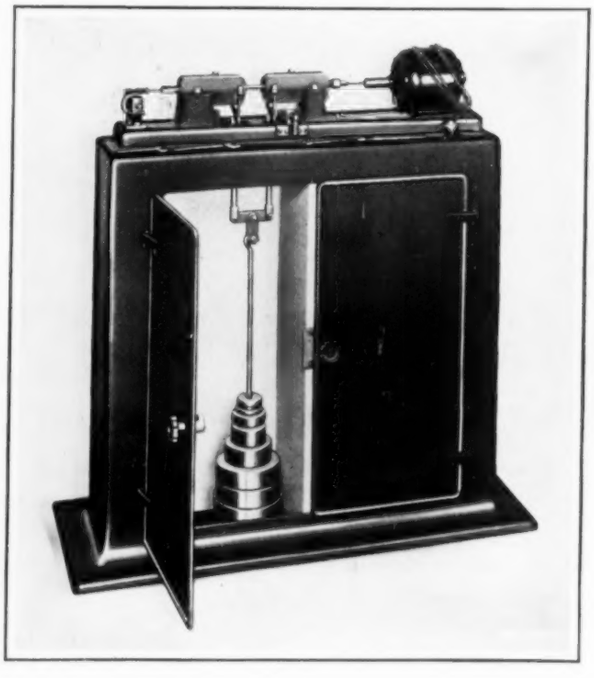
(2) The first additions of tin enter copper in solid solution to form the alpha or common low-tin bronzes. The amount of tin which is taken up is not over 16 per cent, which is the maximum or equilibrium concentration, but it is much less than this for the cooling rates. The solubility is 5 per cent tin or less for chill castings and is in the neighborhood of 10 per cent for slowly cooled alloys. It may be increased to more than this by moderate annealing operation. The pronounced dendritic character of these alloys is responsible for these variations and gives the typical microstructure. The location of the boundary of the alpha field is arbitrary, unless the correct value of 16 per cent tin is used, and this accounts for the lack of agreement among the published diagrams. In reading the present diagram, it is to be borne in mind that the common structure of low-tin bronze is definitely dendritic and that the apparent limit of solubility is 5 per cent or more below that given.

(3) Three peritectic reactions or equilibria occur over this range of tin at which new solid phases become stable with the melt. These solid phases are known as alpha, beta, and gamma. The alpha phase has been discussed and the beta and gamma phases are responsible for transformations in the solid state. Heycock and Neville were not able to differentiate microscopically between beta and gamma and this has recently been confirmed by Matsuda.

(4) When at room temperature the tin content exceeds that which is present in the alpha solid solution, the excess forms a typical eutectoid structure of alpha and delta. When the tin content is in the neighborhood of 10 per cent or less, this delta phase can be eliminated by ordinary annealing.

(5) Two additional phases form which are stable at room temperature. The delta phase is sometimes considered as Cu_3Sn, but some of its physical properties, taken in conjunction with those of neighboring alloys, suggest that it is an intermediate solid solution, rather than an intermediate compound. The Cu_2Sn phase is an intermediate compound. It is polymorphic with a transformation point at 670 degrees Cent., where it changes into gamma. *(Continued on page 108)*

This material from Dr. Hoyt was received too late for inclusion in the 1930 edition of the Metals Handbook. It was prepared at the request of the Nonferrous Data Sheets Committee of the Institute of Metals Division of the A. I. M. E., and the Recommended Practice Committee of the A. S. S. T.



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3 The manufacturing cost of Rustless Iron articles is usually lower than the cost of producing the same articles from other corrosion resistant metals. In many cases Rustless Iron has replaced plated non-ferrous metals with a considerable saving in equipment and labor cost.

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Copper-Tin Alloys (*cont'd*)

The ranges of composition of these two phases are not known with certainty and the boundaries are shown dotted.

There are a few other important features of the constitution of these alloys which have not been definitely settled by the work which has been done to date. While these features are of great interest from the experimental and theoretical sides, they are not known to have any important bearing on the practical handling of these alloys.

(6) A thermal critical point has been observed in the alloys containing from 12 to 26 per cent tin[5] at 590 degrees Cent. The transformation responsible for this heat effect has been the subject of considerable experimentation and discussion and has been held to be due to an eutectoid inversion of beta, or to a polymorphic transformation of beta,[3] or to some feature of the experimental technique used to study the effect. The latter assumption is definitely not consistent with the thermal analysis of the writer and of later experimenters which connects this critical point to the beta phase. While investigators would not all agree on the interpretation of this effect, the writer prefers the eutectoid inversion of Bauer and Vollenbruck[6] which also agrees with the suggestion first put forward in 1913. Thermal analysis shows that the eutectoid point must lie close to the end of the horizontal[4, 5] and the slight jog required here has been found by Raper[7]. This circumstance also accounts for the failure of a typical eutectoid structure to form. The assumption of a polymorphic transformation of beta made by Stockdale and Raper, fails to account for the sudden disappearance of the heat effect at about 25 per cent tin. Raper's diagram would require a heat effect up to 30 per cent tin and above.

(7) The gamma phase, of composition Cu_3Sn, has been assumed to solidify over a range of temperature (Heycock, and Neville) while Giolitti and Tavanti[3] and Bauer and Vollenbruck, who made a careful study of this point, record a constant freezing and melting point for this composition. Matsuda likewise checked this point, as did the writer, and came to the same conclusion. This latter construction has been incorporated in the diagram and is consistent with the physical tests made on the molten copper-tin alloys which indicate the presence of this compound in the liquid state.

(8) The transformation at 580 degrees Cent. involving delta has been variously explained and is usually associated with a eutectoid or peritectoid inversion, or with both. In the later case, a second horizontal is indicated. It is not possible to represent the phase relationships in this region in a way which reconciles the conflicting opinions and the construction shown is that used in a number of the recent copper-tin diagrams. This construction would make it necessary to consider the eutectoid found in the alloys of this region, and reported by Campbell[8], to be the same as that found in the alloys with lower tin.

(9) A unique occurrence was observed by Heycock and Neville in alloys containing just above 40 per cent tin. These alloys solidify completely at a high temperature, but melt partially at a lower temperature as the gamma phase changes to Cu_3Sn.

The difficulties involved in the elucidation of the controversial features of this system are rather great and this accounts for the *(Continued page 116)*

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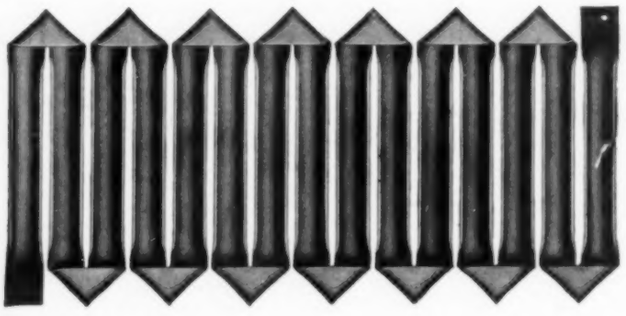

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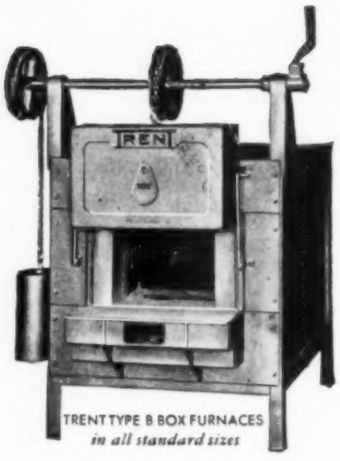

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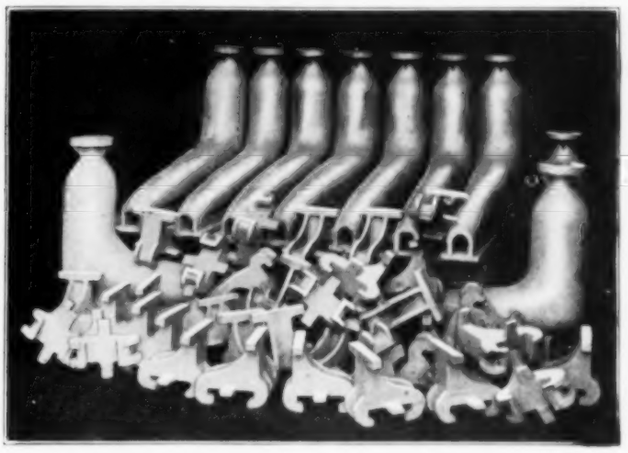

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Copper-Tin Alloy (*cont'd*)

lack of agreement among the published diagrams. The diagram reproduced here is that given by Heycock and Neville, modified by Bauer and Vollenbruck, Stockdale, the writer, and is confirmed by recent work of Matsuda. It corresponds closely to one given by Campbell in the Howe Memorial Lecture for 1926 and to the diagram selected by Guertler and Leitgebel for this system.

The crystal structure or atomic arrangement of the phases of this system have been recently summarized by Elam[10] as follows: The alpha solid solution is face centered cubic while the lattice parameter increases from 3.60 A.u. for pure copper to 3.693 A.u. for the 15 per cent tin alloy. Mehl and Barrett have shown that the tin atoms occupy positions on the lattice as substitutes for the copper atoms[11]. The beta solid solution is body centered cubic with a parameter of 2.972 A.u., while delta is face centered cubic with a parameter of 17.9 A.u. and 416 atoms to the unit cell. The compound Cu_3Sn is hexagonal close packed with the parameters, a and c, of 2.747 and 4.32 A.u.

References

[1]C. T. Heycock and F. H. Neville, Trans. Roy. Soc. of London, 1903, v. 202, A.

[2]W. C. Roberts-Austen, Fourth Report to Alloys Research Committee, Inst. Mech. (London), 1897.

[3]D. Stockdale, J. Inst. Metals, 1925, No. 2, p. 111.

[4]T. Matsuda, Science Repts. Tohoku Imp. Univ. 1928, Ser. 1, v. 17, p. 141.

[5]S. L. Hoyt, J. Inst. Metals, 1913, No. 2, p. 235, 261.

[6]O. Bauer and O. Vollenbruck, Z. Metallkunde, 1923, v. 15, p. 119.

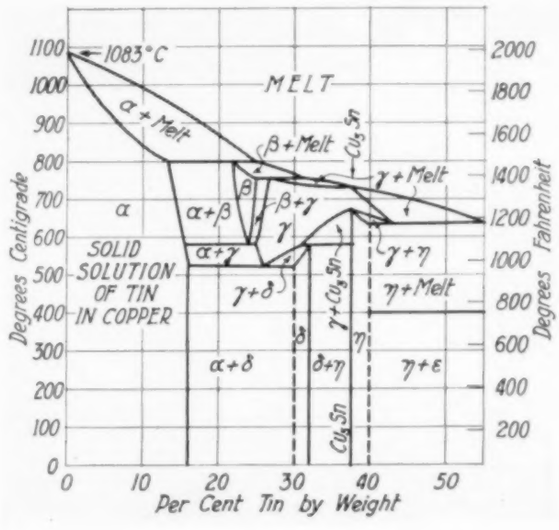
[7]A. R. Raper, J. Inst. Metals, 1927, No. 2, p. 217.

[8]Giolitti and Tavanti, Gazz. Chim. Itali., 1908, p. 209.

[9]W. Campbell, Trans. Am. Inst. Mining and Met. Eng., 1926, v. 73, p. 1135.

[10]C. H. Elam, J. Inst. Metals, 1929, No. 1, p. 329.

[11]R. F. Mehl and C. S. Barrett, Trans. Am. Inst. Mining and Met. Eng., Proc. Inst. Metals Div., 1929.



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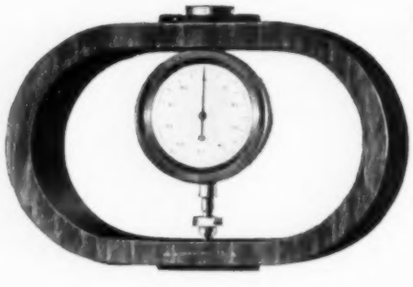

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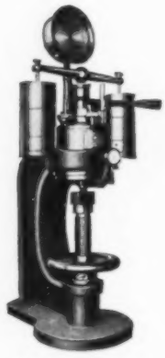

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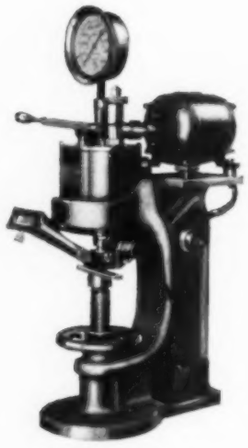

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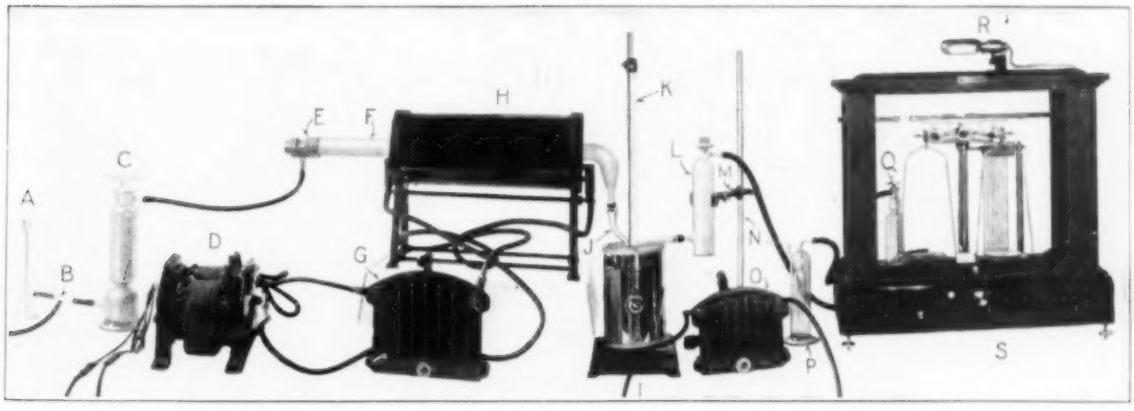

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AIRPLANE MANUFACTURE

HEAT TREATMENT. Heat Treatment of Aircraft Parts, H. C. Knerr. *Am. Soc. Testing Matls.—Advance Paper*, no. 33d, for mtg. June 23-27, 1930, 15 pp.

Purposes of heat treatment and effects thereof upon mechanical properties of metals; metals treated; advantages, from standpoint of design, inspection, storage and processing, of standardizing upon minimum variety of alloys of specified composition; processes of heat treatment for steels and aluminum alloys; furnace equipment; control of furnace atmospheres and temperatures; metallurgical factors; tables of heat-treating data are presented. Bibliography.

WELDED JOINTS. Welding of Tubes in Airplane Construction (Ueber die Schweissung von Rohren im Flugzeugbau), A. Koppenhoefer. *Autogene Metallbearbeitung* (Halle), vol. 23, no. 9, May 1, 1930, pp. 134-137, 7 figs.

Discussion of experiences in welding of steel tubing at E. Heinkel Flugzeugwerke G. m. b. H., Warnemuende; data on tensile strength of welds and tubing; microphotographs show structural changes; welding of tubes in air-plane manufacture.

WELDERS TRAINING. Training Course for Aircraft Welders, R. W. Boggs and S. C. Clark. *Am. Welding Soc.—Jl.*, vol. 9, no. 6, June 1930, pp. 62-76, 17 figs.

Outline of course with qualifications test for aircraft welders.

WELDING. Welding Jigs and Fixtures, J. F. Hardecker. *Aviation*, vol. 29, no. 1, July 5, 1930, pp. 4-9, 8 figs.

Discussion of current practices of representative factories in design of production equipment, for welding purposes; sketches show jigs for fuselage, engine mount, etc.

AIRPLANE MATERIALS

COPPER ALLOYS. Copper and its Alloys in Motors and Aircraft, L. S. Reid. *Aviation Eng.*, vol. 3, nos. 5 and 6, May 1930, pp. 20-22, and June, pp. 17-19, 4 figs.

Notes on composition of bearing metals; tables give data on babbitt metal and phosphor-bronzes.

STEEL. The Highly-Alloyed Steels in Aircraft Construction, J. Strauss. *Am. Soc. Testing Matls.—Advance Paper*, no. 33A, for mtg. June 23-27, 1930, 7 pp.

Brief treatment of corrosion-resisting steels; only those of first importance have been described.

AIRSHIPS

ELECTRIC WELDING. Arc Welding in Airship Construction (Die Lichtbogenschweissung im Flugschiffbau), W. Strelow. *Elektroschweissung* (*Braunschweig*), no. 2, Feb. 1930, pp. 23-26, 6 figs.

Comparison between riveted and welded ship bodies shows difference in weight at equal size; equation for difference in size of ships of same loading capacity; features of arc construction of motor boats.

ALLOY STEEL

Fitting Steel for the Jobs Ahead, F. J. Griffiths. *Universal Engr.*, vol. 51, no. 5, May 1930, pp. 19-23, 5 figs.

Development of steel alloys; percentage of alloy steel used in automobiles; use of rustless steel; heat-treating processes.

ALLOY STEEL CASTING

Effects of Alloys on Rolled and Cast Steels, R. C. Good. *Iron and Steel of Canada* (*Gardenvale, Quebec*), vol. 13, no. 6, June 1930, pp. 121-122, 141 and 143.

Effect of chromium, nickel, manganese and silicon. Paper read before Montreal Section of Am. Soc. Steel Treating.

ALLOYS

Special Alloys (Spezial Legierungen). *Giesserei-Zeitung* (*Berlin*), vol. 27, nos. 8 and 12, Apr. 15, 1930, pp. 221-224, and June 15, pp. 328-330.

Continued description of alloys as follows: Apr. 15: Alumac, Aluman, Aluminac, Aluminit-Cast Alloy; Aluminum Gold, Aluminum Guhr, Aluminum Wegner, Aluminum Willmotts, Aluni, Alusil, Alzen-Metall, Alzin-Metall, Akrit, Amax-Metall, Ambrac Metall, American Alloys and American Silver. June 15: Ampco-Bronze, Anaconda Bronze; Aphtit, Argasoid, Argent Francais, Argent Ruolz, Argental, Argental Brass and Argentan. (Continuation of serial.)

ANTI-CORROSIVE. Heat and Corrosion Resisting Materials, H. D. Phillips. *Blast Furnace and Steel Plant*, vol. 18, no. 7, July 1930, pp. 1143-1147, 9 figs.

Brief notes on properties and characteristics of metals and alloys that are found in modern equipment.

ANTI-CORROSIVE. Resistance of Metals to the System Urea-Water-Ammonium Carbamate, J. G. Thompson, H. J. Krase and K. G. Clark. *Indus. and Eng. Chem.*, vol. 22, no. 7, July 1930, pp. 735-736.

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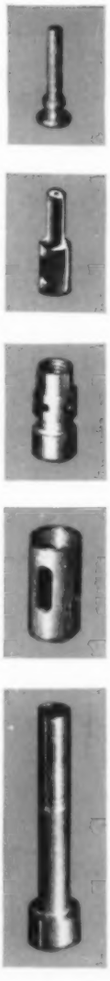

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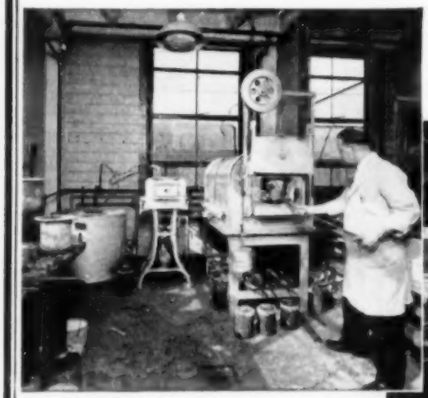

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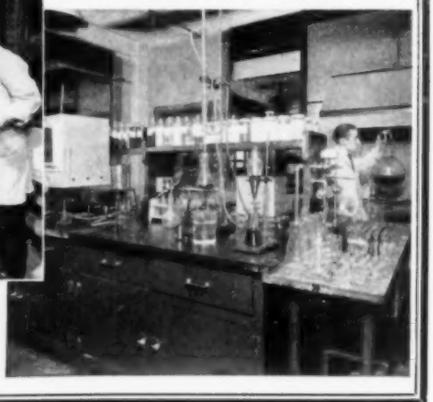

Results of investigation to determine which commercial corrosion-resistant alloys would best meet exacting demands of actual working conditions.

ALUMINUM ALLOYS

Hiduminium—A New Alloy Development. *Metallurgia (Lond.)*, vol. 2, no. 8, June 1930, pp. 52-53, 2 figs.

Notes on alloy developed at laboratory of Rolls-Royce Co., and for which patent has been issued; in place which won Schneider Trophy, crankcase, cylinder block, and cylinder head were produced from this alloy; in addition to aluminum it contains 0.5 to 5.0 per cent copper, 0.2 to 1.5 nickel, 0.1 to 5.0 magnesium, 0.6 to 1.5 iron, to 0.5 titanium, and 0.2 to 5.0 per cent silicon; test data are given.

HYB-LUM. A New High Strength Aluminum Alloy. A. Black. *Airway Age*, vol. 11, no. 6, June 1930, pp. 784-787, 1 fig.

Composition and physical properties of new aluminum alloy which is considerably less affected by salt water than is duralumin; made by Sheet Aluminum Corporation of Jackson, Mich.; notes on methods of determining corrosion loss and yield point; bending tests.

ALUMINUM BRONZE

Aluminum Bronze—A Corrosion Resistant Alloy, R. J. Anderson. *Metallurgia (Lond.)*, vol. 2, no. 8, June 1930, pp. 57-60.

Brief review of development of aluminum bronze, known prior to 1860, but formerly too costly for use as engineering material of construction; compositions and mechanical properties; resistance to corrosion by various media; applications under corrosive conditions. Bibliography.

CASTINGS. Cast Aluminum Bronzes (Gegossene Aluminiumbronzen), W. Claus and F. Goerderitz. *Giesserei (Duesseldorf)*, vol. 17, no. 25, June 20, 1930, pp. 601-610, 78 figs.

Notes on structural formation; macroscopic and microscopic analysis alloys of binary nature with up to 7 per cent aluminum correspond in structure to aluminum-copper diagram of state; irregularities of disintegration; results of investigation and conclusions.

ALUMINUM

CORROSION. Some Factors Contributing to Corrosion of Aluminum, M. I. Makushenko. *Tzvetniye Metalli (Moscow)*, no. 3, Mar. 1930, pp. 348-365, 37 figs.

Report on experimental study made at laboratory of Krassny Viborzhetz plant, in Leningrad, on corrosive effect of river water, acid solutions, cooked rice, etc., upon aluminum ware and samples of aluminum plate. (In Russian.)

RESEARCH LABORATORIES. Organization for Materials Research, J. D. Edwards. *Product*

(Continued on page 180)

How Industry Is Greeting STEEL

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Interesting Articles of the Month

Colonial Pewter Made in 1930 In New Milford, Conn., there is a pewter shop which employs about the same number of people and produces about the same amount of pieces as the pewter shops of colonial times. It is owned by the Merwin-Wilson Co., and was described in the July issue of *Metal Industry*.

Shapes produced there today are exact reproductions of the colonial pewterware. Almost the only difference, in fact, between this modern pewter shop and its predecessors, which helped make Connecticut famous 100 years ago, is that a few more machines are now in use and electric power has replaced the water wheel.

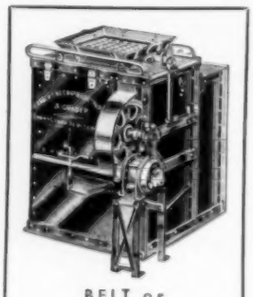
The alloy of tin, copper and antimony is melted over coal fires and cast both into ingots and molds. Ingot-cast pewter is rolled into sheets by small motor-driven rolls and either pressed hydraulically or spun into shapes. Eight is the average number of men employed in the shop to trim, hammer and file the shapes and solder spouts, handles and decorations. Five other men polish the finished pieces.

Metal Sprayed On Paper A lengthly description of a device for spraying molten metal coatings was given in the *Journal* of the Franklin Institute, August 1930. It is said that any commercial metal can be sprayed with the machine, called the metalayer, an adaptation of the Schoop process, either on any other metal or on a nonmetallic surface. The device is connected to supplies of oxygen, acetylene and compressed air. The oxy-acetylene flame melts the metal, supplied continuously in rod or wire, while the air atomizes the molten metal, ejects it from a nozzle and also drives a turbine which operates the rod feeding mechanism. In appearance, the equipment resembles a short nozzled welding blowpipe with three instead of two hose lines.

A coating about 0.001 in. thick is the thinnest which can be laid. The coating solidifies and cools so rapidly that the temperature of the surface being sprayed is raised only slightly. Thin paper and fabrics have been successfully coated.

Forming and Finishing 18-8 The August 2 issue of *Automotive Industries* carried a survey of the current shop methods for forming and polishing the 18-8 type of rustless steel. It was found that the material was more abrasive and required more force to deform than mild sheet steel. Although the ductility of rustless steel is 20 per cent greater than mild steel, it rapidly hardens during cold working.

The abrasive action is so severe that a special drawing lubricant is used to protect the drawing die, the surfaces of which must be so smooth and free from imperfections that they are finished on a stone rather than on an emery wheel. Another means used to prolong the life of dies is to provide greater clearance between the punch and die. *(Continued on page 166)*



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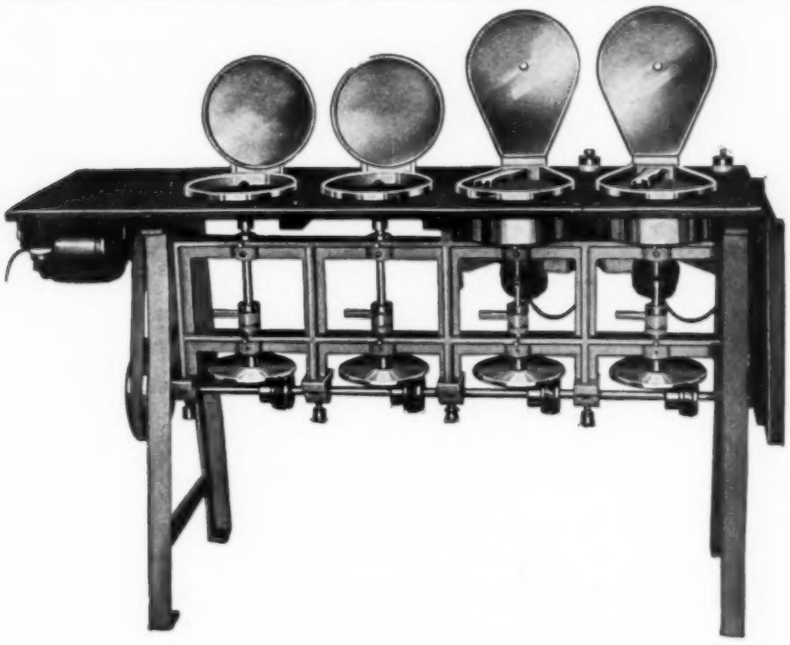

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Finishing (*Cont.*)

Because of the high tensile strength of rustless steel, the blanks must be firmly anchored. More deep drawing operations are required with 18-8 than with mild steel, one company setting the ratio at 5 to 3. Bronze rings and inserts have proved excellent for dies, drawing-rings and punches, but are too expensive. Ford radiator shells are drawn by special cast iron dies and draw rings analyzing 3.25 per cent C; 0.45 Mn; 0.70 Cr; 2.0 Ni; 1.25 Si. After machining, the finished parts of the dies and rings are heated to 1550 deg. Fahr., quenched in oil, reheated to 900 deg. and cooled in air. Punches used for deep drawing are usually "one of the special high-chrome or other alloy steels" on the market.

The severe working of the deep drawing operation hardens rustless steel and compels annealing between draws. After each anneal pickling is necessary because at the annealing temperatures (1900 to 2100 deg. Fahr.) an abrasive scale is formed which quickly ruins the dies. Large, wide-faced wheels are used by many for polishing, although cushion-type ventilated wheels are also employed. One company uses the following routine in polishing: 140 grain emery; 180 grain emery; a flour; a buff with stainless steel compound; and a final wiping with dry buff. Products which do not require high luster are polished with a coarser grain, ranging from 40 to 120. The speed of the wheels varies between 6500 and 8500 ft. per min.

Sponge Iron for Fine Steel Sponge iron should be considered only as raw material for the production of high grade steel, according to an article by Edward P. Barrett, metallurgist at the Bureau of Mines' Experiment Station, Minneapolis, which was published in the August number of *Mining and Metallurgy*. The iron should be electrically melted, particularly if it contains more than the tolerant limit of sulphur. After the sulphur is eliminated the hot metal can be transferred to an open-hearth furnace for finishing, a *(Continued on page 168)*

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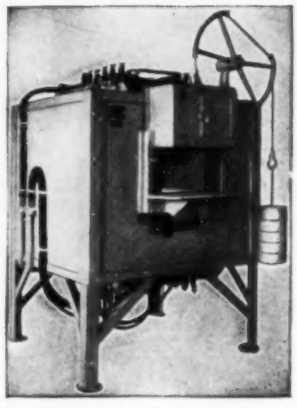

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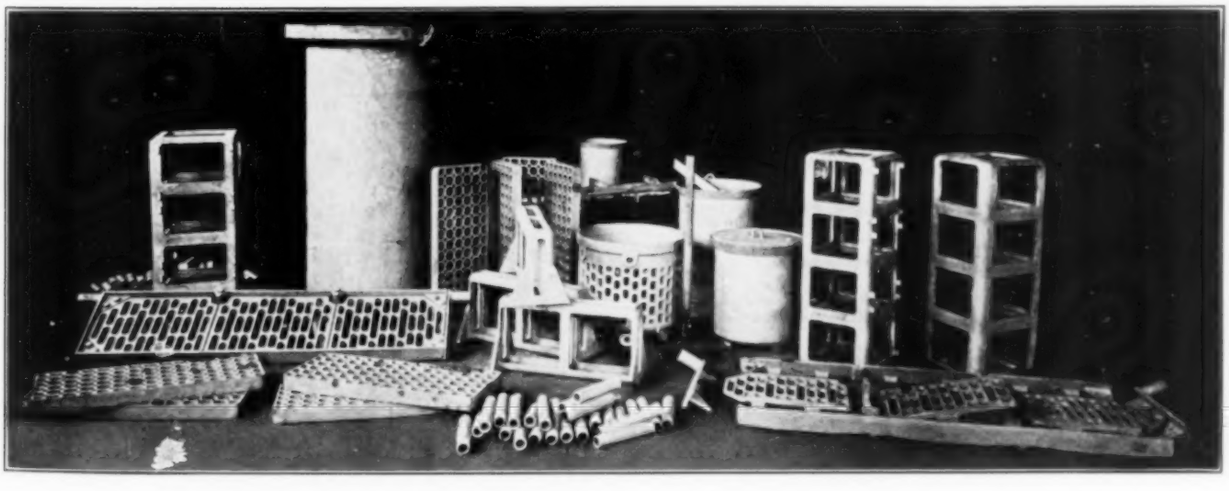

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Sponge Iron (*Cont.*)

good plan when making heats, put sponge iron and part soap. From 500 to 1000 kwh. is required to melt one ton of sponge iron and to eliminate the sulphur. The cost is higher than for melting an equal amount of scrap in an open-hearth, but the excellence of the steel which can be produced from sponge iron may be worth the higher cost.

It is metallurgically but not commercially possible to produce pig iron from sponge iron, since the cost of melting and carburizing in an electric furnace is prohibitive. In places far from steel producing centers, where transportation costs are high and electric power cheap, it might be practicable to use a limited tonnage in grey iron foundries using electric furnace melting. The sponge iron process is not a rival of the blast furnace for making pig iron, in the opinion of the author.

Steel Wire Made in Mexico Mexico is a wire producing country, according to Kenneth B. Lewis' article in the July *Wire*, but despite literally thousand per cent increases in the production of some wire mills the present output is low and the cost high.

All recent Mexican administrations have demonstrated their sincere desire to help the country's steel industry, but since they have also been interested in the farmer's welfare, they have let such products as barbed wire come into the country duty free. Consequently, the steel industry there will have to become large enough to meet Mexico's requirements before it can get real protection.

Mexican wire is expensive because only two plants produce wire rods and the duty on imported rods is high. Sulphuric acid is expensive, and so is coal. The low cost of labor is almost offset by the very natural disinclination to work in a hot climate.

The managing personnel of the wire companies is, as a whole, progressive, but the present tariff impasse, according to the author, is really an important obstacle to the further development of the Mexican wire industry.

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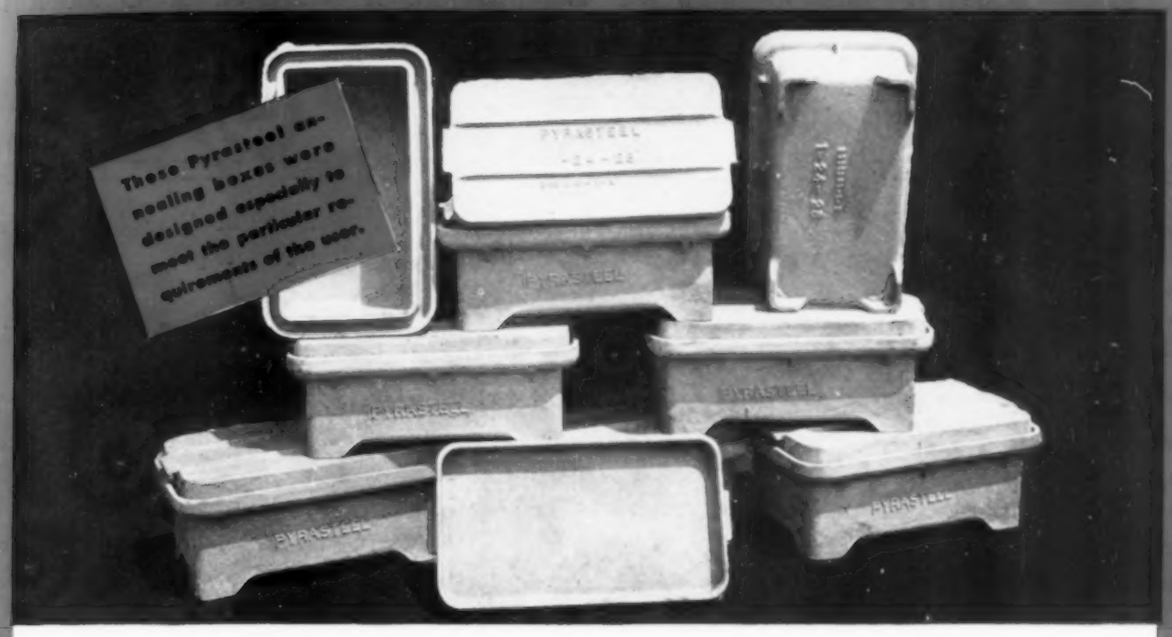

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Reviews of Recent Patents

by Nelson Littel, Patent Attorney
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Process of Treating Ferrous Metal Articles, by Marlin C. Baker and Wilbert A. Dingman, assignors, to Parker Rust Proof Co., of Detroit. 1,761,186, June 3, 1930.

This invention relates to the treatment of ferrous metal articles for the purpose of preparing them for coating with lacquers or enamels, and describes a process for providing a rust proof chemically adherent coating. The particular solution of phosphoric acid is used after the articles are suitably cleaned and then the articles are heated to a temperature of about 500 deg. Fahr. and then plunged into a bath of diluted ortho-phosphoric acid; then after a period of a minute or two the articles are baked at between 325 to 450 deg. Fahr. The heat treatment reduces the time to one-third that required by the Coslett process.

Alloy Steel and Method of Making the Same, by Richard E. Bissell, of Cleveland Heights, Ohio, assignor to Thompson Products, Inc. 1,761,866, June 3, 1930.

This patent describes a valve steel which is capable of resisting the action of heat corrosive gases, and which can be hard at ordinary temperatures and at red heat. The method described is for treating an austenitic alloy consisting principally of iron in 11.5 to 13 per cent chromium, 7 to 8 per cent nickel, 2 to 3 per cent silicon, and 0.25 to 0.35 per cent carbon which includes heating from two to six hours at about 1600 deg. Fahr., and *(Cont. on p. 174)*

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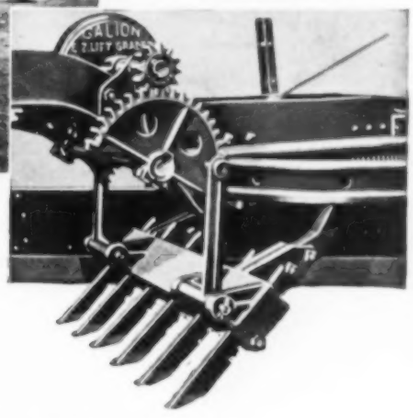
A close-up of the scarifier attachment used with Galion Graders. Note the six reversible Chrome-Vanadium teeth.



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Ferro-Titanium	25%
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Patents

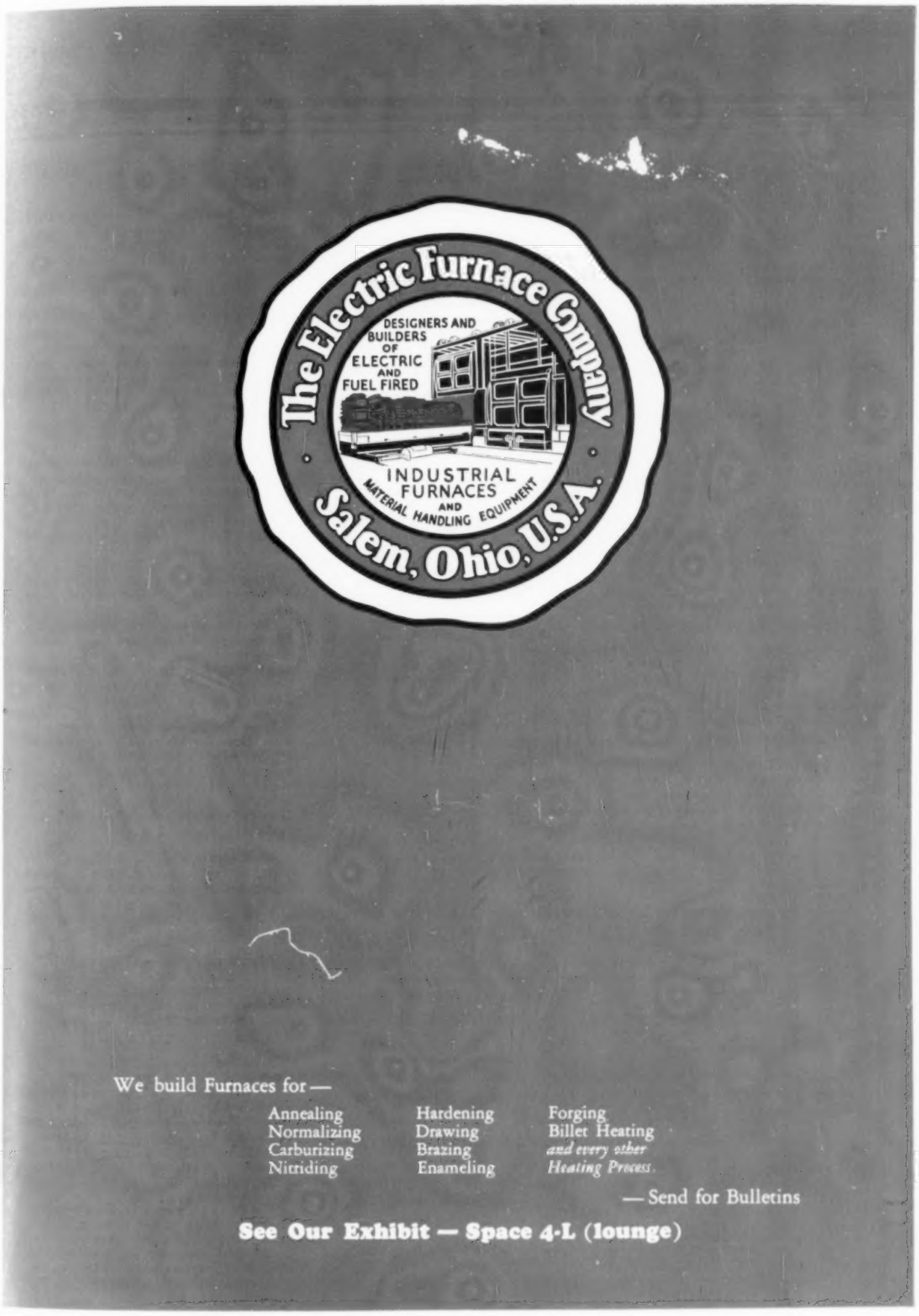
then slowly cooling to render martensitic and hard. The structure of the steel is particularly described, and it is pointed out that either or both chromium and nickel may be added when the austenitic structure becomes more and more stable, and at 20 per cent nickel in 15 per cent chromium, the alloy is substantially wholly austenitic, irrespective of any kind of heat treatment.

Process of Desulphurizing Ferrous Metal, by Harry L. Frevert, of Philadelphia. 1,770,395, July 15, 1930.

Dr. Frevert desulphurizes ferrous metal, such as cast iron, and the particular product has an effective and economical action which does not tend to produce a thick slag. The process includes melting the metal in a furnace, and after adding to the metal and bringing into intimate effective contact therewith outside the melting zone a desulphurizing agent of sodium carbonate in a major proportion and a fluoride in a minor proportion in a substantial absence of lime. It is sufficient to add 10 or 15 lb. of the mixture to eliminate 30 to 50 per cent of the sulphur from cast iron.

Alloy, by William Robert Saltrick, of Purley, Eng., assignor to Robert Wickersham Stimson, of New York. 1,770,433, July 15, 1930.

Richer alloy steels, including special tool steels are covered herein, and the patent includes the process of manufacturing corrosion resisting steels and irons and other steels wherein more than the chemically prescribed quantity of metalliferrous matter—comprising an oxide of an alloying element—and a silicon-containing metallic reducing agent, are associated and smelted above liquid metal comprising the element iron; which comprehends preparing a suitable bath of appropriate ferrous metal to be alloyed in a furnace, and thereafter adding the above mentioned reactive agents to, also applying heat to, molten slag lying upon the liquid metal, the amount of metalliferrous matter being sufficient to keep silicon substantially out of the metal bath.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Industrial Regulators—Minneapolis-Honeywell Regulator Co. Booklet describing their motorized valves used in furnace temperature regulation. These valves operate with their regulators or with any pyrometric controller to regulate flow of gas, oil and air. Ask for Bulletin No. A-2.

Resistance Thermometers—Leeds and Northrup Co. Revised catalog treating in detail resistance thermometers for recording, controlling and indicating temperatures, covering heating and ventilating, applications in refrigeration and chemical plants, gas-making and other low temperature applications. Ask for Bulletin No. A-3.

Induction Furnaces—Ajax Electrothermic Corp. This bulletin gives latest information regarding coreless induction furnaces in capacities up to several tons, and motor-generator equipments for energizing the furnaces. Ask for Bulletin No. A-9.

Non-Rusting Steel—Bethlehem Steel Co. Bethalon, a new non-rusting steel is fully described in an illustrated booklet. Bethalon combines complete immunity to corrosion with the easy machinability of screw stock. Ask for Bulletin No. A-1.

Temperature Controllers—Wilson-Maeulen Co. Booklet entitled "An Inspection Tour of Industrial Plants Showing Wilson-Maeulen Automatic Temperature Controllers in Use." Illustrated with 18 photographs of control applications. Ask for Bulletin No. A-6.

Tool Steel Handbook—Columbia Tool Steel Co. Booklet contains valuable information concerning the making of tools, heat treating, application of steels, with tables, etc., gratis. Ask for Bulletin No. A-13.

Gas Carburizers—American Gas Furnace Co. Booklet on rotary retort and vertical retort gas carburizers. Description of machines and vertical retort furnaces used for carburizing employing either gas or compound, or a combination as the carburizing medium. Illustrated. Ask for Bulletin No. A-14.

Tool Steels—Carpenter Steel Co. Bulletin illustrating and describing methods for testing the uniformity of tool steel. Discusses uniform hardness penetration, etc. Published by the research department. Ask for Bulletin No. A-4.

Steel Refining—Densite Corp. of America. A folder in the form of a chart showing physical properties and photomicrographs of structures and inclusions of various carbon steels refined with Densite. Chart is of especial interest to metallurgists and heat treaters. Ask for Bulletin No. A-5.

Special Analysis Steels—Wheelock, Lovejoy & Co. Folders give analysis Hy-Ten steel ranges in carbon from .10 to 1.00 per cent. There is a Hy-Ten grade for every vital machine part. Ask for Bulletin No. A-12.

Gas Heat—American Gas Association. A text-book on the uses of gas in industry, giving comprehensive data on industrial gas heat. Illustrated. Free. Ask for Bulletin No. A-7.

Heat Resisting Alloys—General Alloys Co. General catalog on Q-Alloys, which has recently been prepared describing many applications of heat resisting alloys. Ask for Bulletin No. A-15.

Belt Conveyor Furnace—Electric Furnace Co. Eight-page bulletin with 16 illustrations, describing new gas and electric chain belt conveyor furnaces, heat treating miscellaneous small and medium size parts and products without pans or trays. Ask for Bulletin No. A-16.

Pickling Equipment—Weaver Bros. Co. Catalog listing equipment and supplies now available. Depicts all necessary equipment and has new "theory and practice of pickling." Ask for Bulletin No. A-17.

Steel Handbook—Jos. T. Ryerson & Sons, Inc. Handbook on Tool and Alloy Steels. Description, technical data and general information on tool and alloy steels. Also nontechnical description of heat treating methods and shop practice applying to various steels. Ask for bulletin No. A-8.

Heat Resisting Steels—Midvale Co. Booklet is largely a diagrammatic classification showing the content of the various alloys. It was produced because of a large number of requests for exactly this type of information. Ask for Bulletin No. A-11.

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Allegheny Metal—Allegheny Steel Co. Bulletin describing this unrusting, untarnishing, unstaining chromium nickel alloy will be sent on request. Ask for Bulletin No. A-18.

Stainless Irons—Republic Steel Corp. Series of booklets descriptive of Enduro Stainless Irons. Each booklet is devoted to a single type of stainless and contains complete fabrication data, and descriptions of the physical and chemical properties. Ask for Bulletin No. A-19.

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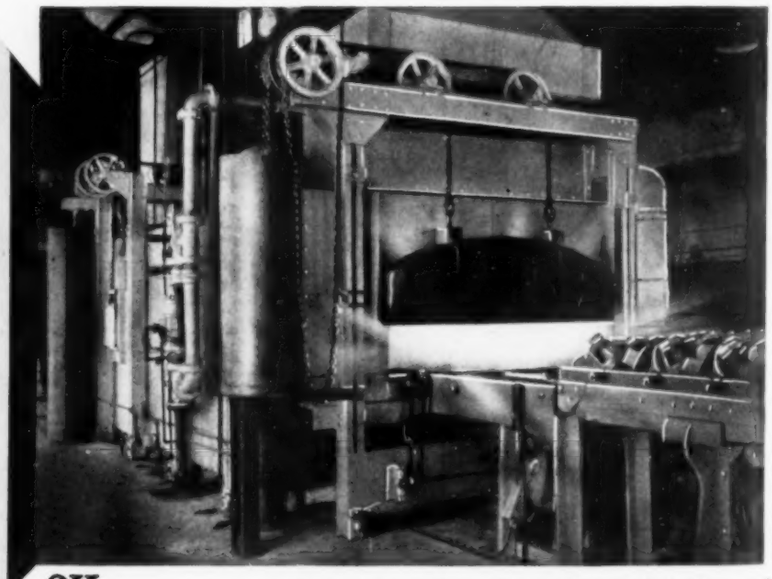

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Eng., vol. 1, no. 7, July 1930, pp. 324-326, 4 figs.

Description of New Kensington laboratory which has 56,000 sq. ft. of working space and houses staff of 150.

SPINNING. Aluminum Spinning Practice, R. J. Anderson. *Metal Stampings*, vol. 3, no. 6, June 1930, pp. 513-518, 3 figs.

Operations involved in spinning of aluminum; equipment and tools required; auxiliary operations of necking, grooving, bulging and trimming parts drawn in presses.

BEARING METALS

CASTING. Improvements in Melting and Casting of Bearing Metals (Verbesserungen in der Schmelz und Giessbehandlung der Lagerweissmetalle), C. Kroemer. *Werkstattstechnik (Berlin)*, vol. 24, no. 11, June 1930, pp. 293-297, 22 figs.

Notes on operation of melting furnaces; sketches show casting fixtures and molds for typical bearings.

BRONZE. Bearing Bronzes with Additions of Zinc, Phosphorus, Nickel and Antimony, E. M. Staples, R. L. Dowdell and C. E. Eggenschwiler. *Soc. of Automotive Engrs.—Jl.*, vol. 27, no. 1, July 1930, pp. 45-54 and (discussion) 54-55, 16 figs.

Basic copper-tin-lead bearing bronzes having high copper contents were studied by application of Brinell hardness, resistance to impact, resistance to repeated pounding and resistance to wear; chemical analyses are given for 40 different alloys tested; results of various tests on each group of alloys, with observations charted and tabulated for convenient reference; specifications of 54 different bearing bronzes now in use.

BELLS

FOUNDING—Britain's Bell Foundries, J. R. Nichols. *Metal Industry (Lond.)*, vol. 36, no. 24, June 13, 1930, pp. 621-623, 4 figs.

History of bell founding in Leicestershire, and description of Loughborough Foundry. (Continuation of serial.)

BLAST FURNACE PRACTICE

The Modern Blast Furnace and Its Operation, R. A. Hacking. *Metallurgia (Lond.)*, vol. 1, nos. 5, and 6, vol. 2, no. 7, Mar. 1930, pp. 195-196, Apr., pp. 235-237, and May pp. 27-28, 3 figs.

Mar.; Theoretical aspects of main tendencies in modern blast furnace operation. Apr.; Thermal considerations; conditions of hearth and shaft. May: Use of higher blast temperatures; theoretical considerations; operating results; practical difficulties; future developments. (To be continued.)

BOILER MANUFACTURE

WELDING. Reliability of Materials Analysis in Welded Seams of Boiler Parts (Die Zuverlaessigkeit der Feststellungen der Werkstoffeigenschaften in Schweissnaehten der Kesselteile), E. Helfrich. *Zeit. des Bayerischen Revisions-Vereins (Munich)*, vol. 34, no. 11, June 15, 1930, pp. 155-157.

It is claimed that properties of weld cannot be determined from weld specimen and therefore determination of properties in specimen is not reliable criterion.

BRASS

CHROMIUM PLATING. Chromium Plating on Brass. *Metal Industry (Lond.)*, vol. 36, no. 26, June 27, 1930, pp. 673-674.

Comparison of British and American practice; proposed U. S. Government Master Specifications.

FOUNDRY PRACTICE. The Fundamentals of Brass Foundry Practice, R. R. Clarke. *Metal Industry (Lond.)*, vol. 36, no. 24, June 13, 1930, pp. 633-634, 5 figs.

Practice in melting, pouring, and casting copper.

HEAT TREATMENT. Proper Heat Treatment Reduces Stress-Corrosion Cracking of Brasses. *Fuels and Furnaces*, vol. 8, no. 7, July 1930, pp. 935-936, 2 figs.

Determination of relative resistance of various commercial brass mixtures to stress-corrosion cracking; effect of quenching; effect of grain size.

(Continued on page 196)

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CAST IRON

HEAT TREATMENT. Heat Treatment of Grey Cast Iron, R. Whitfield. *Foundry Trade Jl. (Lond.)*, vol. 42, no. 722, June 19, 1930, pp. 455-457 and 459.

Comparison of low and high-temperature treatment; heat treatment of various types of iron castings; practices in various plants for softening cast iron by annealing to facilitate machining; effect of quenching on hardness of specimens of different compositions; batch-type casting annealing furnaces.

HEAT TREATMENT. Heat-Resisting Cast Iron, J. W. Donaldson. *Metallurgia (Lond.)*, vol. 2, no. 7, May 1930, pp. 29-30.

Review of research; discussion of experiments described by same author in paper indexed in Engineering Index 1928, p. 345; stability of combined carbon; effects of other constituents. Bibliography.

HIGH TEST. Production of High Test Cast Iron, G. Neuendorff. *Metals and Alloys*, vol. 1, no. 13, July 1930, pp. 620-625, 6 figs.

Outline of development and present status of principal processes; discussion of improvement by favorable crystallization of pearlitic ground-mass, improvement by decreasing amount of graphite as well as refining of graphite crystallization; improvement by addition of alloying elements; special reference to German achievements.

PROPERTIES. Gray Iron Possesses Valuable Engineering Properties. *Foundry*, vol. 58, no. 13, July 1, 1930, pp. 94-97, 4 figs.

Discussion of principles of transverse test method; ultimate fiber stress of gray iron is shown by modulus of rupture which can be calculated from transverse test values; typical stress-strain curves of cast iron in tension and compression. (Continuation of serial.)

CASTINGS

SHRINKAGE. Methods of Determining the Volume Changes Undergone by Metals and Alloys During Casting, C. M. Saeger, Jr., and E. J. Ash. *Am. Foundrymen's Assn.—Trans.*, vol. 1, no. 6, June 1930, pp. 107-145, 14 figs.

Methods proposed and used for determining various types of shrinkage undergone by cooling metal; sand-cast-cone method for determining shrinkage during casting and more fundamental procedure of constructing specific volume-temperature curve for each metal or alloy from room temperature to some temperature well above melting point or melting range.

CHROMIUM STEEL

Report of Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys. *Am. Soc. Testing Matls. — Advance Paper No.* 17, for mtg. June 23-27, 1930, 3 pp.

General committee activities; subcommittee activities on classification of data, nomenclature, methods of chemical analysis, and corrosion testing.

CHROMIUM-MANGANESE STEEL

DRAWING PROPERTIES. Deep Drawing Properties of Chromium-Manganese Steels, F. M. Becket. *Metal Stampings*, vol. 3, no. 6, June 1930, pp. 543-544, and 555-556.

Discussion of corrosion resistance and cold working qualities of high chromium-manganese steels.

COPPER ALLOYS

System of Copper Alloys with Alpha Phase and Variable Limits and Their Use in Hardening Copper (Systeme d'alliage de cuivre avec phase alpha et a limites variables et leur emploi pour le durcissement du cuivre), G. Corson. *Revue de Metallurgie (Paris)*, vol. 27, no. 5, May 1930, pp. 265-281, 32 figs.

Structure of pseudo-binary alloys is discussed and illustrated by diagrams and photomicrographs; comparison of alloys described with those of Read and Greaves.

STAMPING. Properties of Press Bars of Electrolytic Copper, Refined Copper, Copper Alloyed with Arsenic, and Aluminum Bronze with 4 Per Cent Aluminum in Relation to Stamping Conditions (Ueber die Eigenschaften von Presstangen, etc.), P. Siebe and G. Elsner. *Zeit. fuer Metallkunde (Berlin)*, vol. 22, no. 6, June 1930, pp. 203-206, 3 figs.

Influence of different pressing, drawing, and annealing conditions is studied.

COPPER SHEETS

CRACKING. Dressing of Heavy Sheets of Firebox and Trade Copper, W. G. Serdyakov. *Tzvetniye Metalli (Moscow)*, no. 4, Apr. 1930, pp. 516-530, 33 figs. partly on supp. plate.

Results of experience and tests in Russian locomotive plant; formation of cracks and its causes, with special reference to "hydrogen illness" as causative agent; methods of preventing crack formation. (In Russian.)

COPPER WELDING

Copper Welding in the Chemical Industry, S. J. Mashl. *Am. Welding Soc.—Jl.*, vol. 9, no. 6, June 1930, pp. 46-52, 9 figs.

Physical properties of copper and its action under acetylene flames; welding procedure used.

CRANKSHAFTS

FAILURES. Failure of a Crankshaft, H. W. Keeble. *Metallurgia (Lond.)*, vol. 2, no. 7, May 1930, pp. 35-36, 4 figs.

Crankshaft 2½ in. diameter, fitted to air compressor, failed after 18 months' service; examination of type of fracture, its position, and quality of material of which shaft was made, revealed defects in design of crankshaft, and in its quality and heat-treatment received; results of laboratory investigation.

CRYSTALS

The Metal Crystal, H. Carpenter. *Nature (Lond.)*, vol. 126, no. 3160, July 5, 1930, pp. 17-28, 8 figs.

Discussion of methods of preparing piece of metal in form of single crystal by production of crystal from vapor phase, by production from liquid phase, and by conversion of solid metal in ordinary polycrystalline aggregate into single crystal.

X-RAY ANALYSIS X-Ray Crystal Analysis in Engineering, V. E. Pullin. *Engineer (Lond.)*, vol. 150, no. 3886, July 4, 1930, pp. 2-4, 33 figs. partly on supp. plate.

Explanation, in general way, of what crystal analysis depends upon and how it is done, shows from some typical spectra how their interpretation is important in general engineering practice.

DIE CASTING

Die-Casting Today, M. Stern. *Am. Mach.*, vol. 72, no. 26, June 26, 1930, pp. 1029-1031, 7 figs.

Wide variety of uses of die casting made possible by development in alloys and improvement in methods.

Control of Materials Features Die Casting Plant, H. R. Simonds. *Foundry*, vol. 58, no. 12, June 15, 1930, pp. 69-72, 8 figs.

Organization and equipment at new plant of Allied Die Casting Corp., Long Island City, N. Y.; data on operation of die casting machines and dies; cost record system is illustrated by blank forms; composition of zinc and aluminum for castings, and steel alloys for dies, is given.

ZINC BASE ALLOYS. Modern Zinc Base Die Casting, W. M. Pierce. *Metals and Alloys*, vol. 1, no. 12, June 1930, pp. 544-546, 6 figs.

Discussion of problems involved in securing suitable alloy and advances in perfecting zinc-base alloys for die casting; requirements of die-casting alloy; zinc-base alloys; zinc-aluminum alloy system; data on physical properties and composition.

MACHINES. Design of Automatic Die-Casting Dies, C. O. Herb. *Machy. (N. Y.)*, vol. 36, no. 11, July 1930, pp. 865-869, 8 figs.

Dies for zinc castiag of such shape that movable die must be completely opened sidewise.

DURALUMIN

CORROSION. Pressure-Aging of Duralumin, L. Pessel. *Indus. and Eng. Chem.*, vol. 22, no. 7, July 1930, pp. 776-777.

Theory of corrosion of duralumin; physical properties of duralumin aged with and without pressure.

ELECTRIC FURNACES

ELECTRODE REGULATION. Automatic Regulation of Electrodes (La Regulation Automatique des Electrodes). *Jl. du Four*

Duralumin sheet in salt bath

DURALUMIN was as yet a new material among alloys when this salt bath furnace for heat treating duralumin sheet was designed, built and installed by *Strong, Carlisle & Hammond* Engineers for a well known army airplane builder in Cleveland. It is at present in constant use by the Great Lakes Aircraft Corporation, large consumers of duralumin for aircraft structural parts.

Sheet duralumin, 24" wide, is heat treated in the salt bath furnace for 15 minutes at 940° to 950° Fahr. The sheet is taken from the heat and cold water quenched, then scrubbed in luke-warm water to remove salt, and finally passed through straightening rolls. Forming and bending must be done within 30 minutes after removal from furnace. After aging for 24 hours, the treated duralumin attains a Rockwell hardness of 90°.

S C & H electric oven furnaces are used for heat treating duralumin rivets. Work is treated in small baskets, and delivered from furnace to workmen every 20 minutes to avoid aging of the alloy before it is worked.

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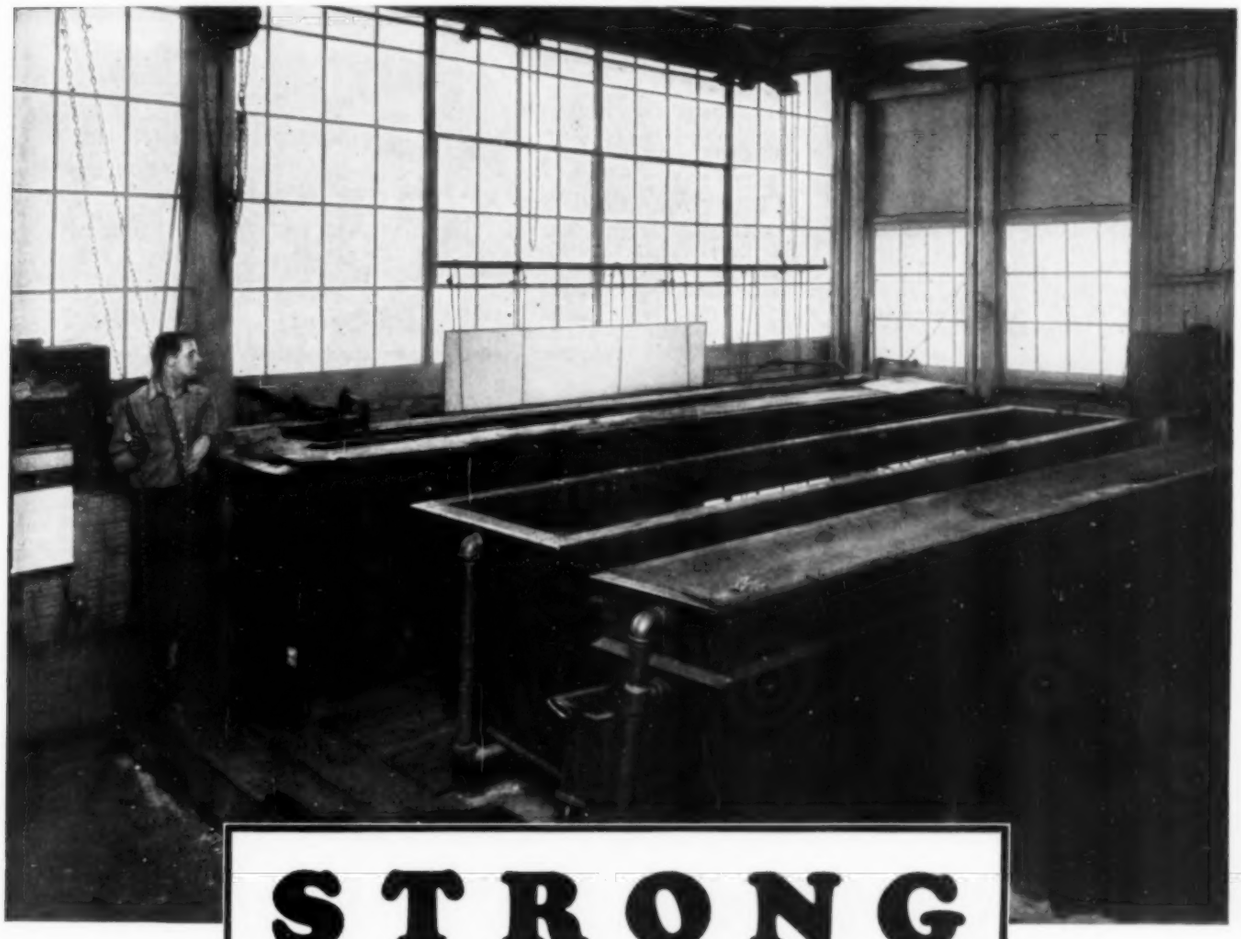

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SC&H Furnaces are built in all sizes of Oven, Pot, Continuous, and Special Types for Electric, Oil or Gas application.

INDUSTRIAL FURNACE MANUFACTURERS · CLEVELAND, OHIO

Electrique (Paris), vol. 39, no. 5, May 1929, pp. 179-180, 2 figs.

Armas system of electrode regulation for electric furnaces is described; it was first introduced in Sweden and is also employed in France in "Rennerfelt" furnaces.

ELECTRODES. Wider Use of the Soderberg Self-Baking Electrode, J. Silberstein. *Iron Age*, vol. 126, no. 2, July 10, 1930, p. 94.

Care to be taken in use of this type and savings resulting from absence of butts and less air corrosion of electrode.

FOUNDRY. Automatic Regulation of Electric Furnaces in the Foundry (La regulation automatique des fours electriques de fonderie), A Levasseur. *Revue Generale de l' Electricite (Paris)*, vol. 27, no. 17, Apr. 26, 1930, pp. 665-670, 7 figs.

Advantages of automatic regulation; variation of input power in relation to resistance; pyrometric regulation; automatic regulation of electrode furnaces.

HEAT TREATING. Heat-Treatment—Electric Furnace for Duralumin Sheet, R. J. Anderson. *Metallurgia (Lond.)*, vol. 2, no. 7, May 1930, pp. 1-3, 4 figs.

Brief description of new-type electric furnace designed especially for heating duralumin-type sheet prior to quenching; furnace, as designed, or with certain modifications, is also well adapted for annealing of aluminum and aluminum-alloy sheet and other manufactures, and for heat-treatment of castings; design; construction; operation; operating costs.

HEAT TREATING. Electric Salt or Lead-Bath Furnaces (Elektrische Salz oder Bleibadoefen), H. Illies. *Feuerungstechnik (Leipzig)*, vol. 18, no. 9/10, May 15, 1930, pp. 81-82, 3 figs.

Advantages and possibilities of steel hardening in salt and lead baths; Russ electric crucible furnace; lead-bath furnace of Hoskins Electric Furnace Co.; electric pot furnace of American Electric Furnace Co.

HIGH FREQUENCY. Electric Furnaces, N. R. Davis and C. R. Burch. *Elec. Rev. (Lond.)*, vol. 106, no. 2743, June 20, 1930, pp. 1171-1172, 1 fig.

Development of high-frequency induction furnace for production of steel on crucible principle, developed by Metropolitan Vickers Electrical Co. Abstract of paper read before Manchester Assn. Engrs.

INDUSTRIAL. Electric Furnaces in Modern Industry (Les fours electriques dans l'Industrie moderne), B. Lacaze. *Revue Industrielle (Paris)*, vol. 60, no. 225, June 1930, pp. 341-350, 14 figs.

Notes on arc furnaces; Scott three phase-two phase connection; manufacturing processes carried out in arc furnaces; Solderberg electrodes; outstanding types of arc furnaces.

NITRIDING. Nitridation of Steels in Electric Furnaces (La Nitruration des Aciers au Four Electrique), Daubois. *Jl. du Four Electrique (Paris)*, vol. 39, no. 4, Apr. 1930, pp. 133-134, 3 figs.

Description of electric nitriding furnace, type 3C of Aubert and Duval system; composition of steel employed. Translated from Arts et Metier.

ELECTRIC INSULATING MATERIALS

HARDNESS TESTING. Hardness Testing of Hard Paper and Press Board [Beitrag zur Haertepruefung von Isoloerstoffen (Hartpapier und Presspan)], H. Staeger and H. Tschudi. *Schweiz. Elektrotechnischer Verein—Bul. (Zurich)*, vol. 21, no. 7, Apr. 7, 1930, pp. 225-237, 13 figs.

Results of various hardness tests under different conditions and test equipment are discussed; suggestions for specifications are given.

ELECTROPLATING

HARDNESS TESTING. The Hardness of Electrodeposits, A. W. Hothersall. *Brass World*, vol. 26, no. 6, June 1930, pp. 159-161.

Definition of hardness; methods of testing hardness of metals by indentation and abrasion; results of Brinell hardness and abrasion tests of electroplated metals and comparison with metals. Abstract of paper read before Electroplaters' and Depositors' Tech. Soc.

ELECTRIC WELDING

ARC. Industrial Progress, H. M. French. *Min. and Met.*, vol. 11, no. 283, July 1930, pp. 352-354, 5 figs.

Metallic arc, carbon arc, atomic hydrogen arc and shielded-arc methods are briefly described; major applications of each are noted.

ARC. Graphical Analysis of Metal Transfer Processes in the Electric Arc (Ueber die graphische Zerlegung der Metalltransportvorgaenge im elektrischen Lichtbogen), P. Flamm. *Elektroschweissung (Braunschweig)*, no. 2, Feb. 1930, pp. 27-30, 2 figs.

Arc welding is time process; origin of drops is determined by experiment; influencing size of drops; melting characteristics of metal electrodes and their fundamentals in conditional diagram; valuation of metal electrodes.

ARC. Facts Concerning Automatic Arc Welding, A. M. Candy. *Welding*, vol. 1, no. 9, July 1930, pp. 599-601, 6 figs.

Advantages, limitations, speeds obtainable and some of applications are discussed.

ARC. Recent Progress in New Electric Welding Processes (Progres recents realises dans les nouveaux procedes de soudure electrique), *Revue Generale de L'Electricite (Paris)*, vol. 27, no. 20, May 17, 1930, pp. 787-794, 9 figs.

Discussion of bulletin issued by Societe d'Encouragement pour l'Industrie Nationale; notes on Kjillberg process of arc welding, of manual arc welding, automatic arc welding; description of modern equipment and improved procedure; advantages of automatic and semi-automatic welding; modern applications.

ARC. Jet Cutting and Electric Welding. *Machy. (N. Y.)*, vol. 36, no. 923, June 19, 1930, pp. 369-377, 20 figs.

Account of new applications and welding equipment.

ARC—FLUX COATINGS. Influence of Flux Coated or Covered on the Metal Arc Electrode, H. Haramiishi. *Am. Welding Soc.—Jl.*, vol. 9, no. 6, June 1930, pp. 33-46, 7 figs.

Investigation of chemical change which takes place at end of tip of electrode in metallic arc welding, using flux-coated electrode.

ELECTRODE. Electrode Research, M. Haramiishi. *Welding Jl. (Lond.)*, vol. 27, no. 321, June 1930, pp. 174-177, 17 figs.

Abstract of results of investigations of flux-coated and covered electrodes for metallic arc welding.

ELECTRIC WELDING MACHINES

Welding Equipment in Steel Construction (Geraete fuer das Schweissen im Stahlbau), W. Vaas. *Elektroschweissung (Braunschweig)*, no. 2, Feb. 1930, pp. 31-33, 4 figs.

Various types of German-made portable and stationary equipment are illustrated and described.

POWER FACTOR. Improvement of Power Factor for Welding Machines (Ueber die Verbesserung des Leistungsfaktors von Schweissmaschinen), J. C. Fritz. *Elektroschweissung (Braunschweig)*, no. 2, Feb. 1930, pp. 34-36, 4 figs.

It is shown that improvement can be obtained by parallel connection of condensers; advantages obtained are discussed.

SELECTION. Viewpoints for the Selection of Arc Welding Machines (Gesichtspunkte fuer die Wahl von Lichtbogenschweissmaschinen), G. Falck. *Elektroschweissung (Braunschweig)*, no. 5, Mar. 1930, pp. 51-55, 10 figs.

Fundamental principles in solution; capacity, no-load consumption; efficiency; statical and dynamic characteristics are explained with examples; valuation of arc welding machines is founded on knowledge of these factors.

TESTING. Explanation of Rules for the Valuation and Testing of D.C. Arc Welding Machines (Erlaeuterungen zu den Regeln fuer die Bewertung und Pruefung von Gleichstrom Lichtbogenschweissmaschinen), A. Danz. *Elektroschweissung (Braunschweig)*, no. 5, May 1930, pp. 85-86.

Rules developed by professional committee for welding practice of Verband Deutscher Elektrotechnischer are explained.

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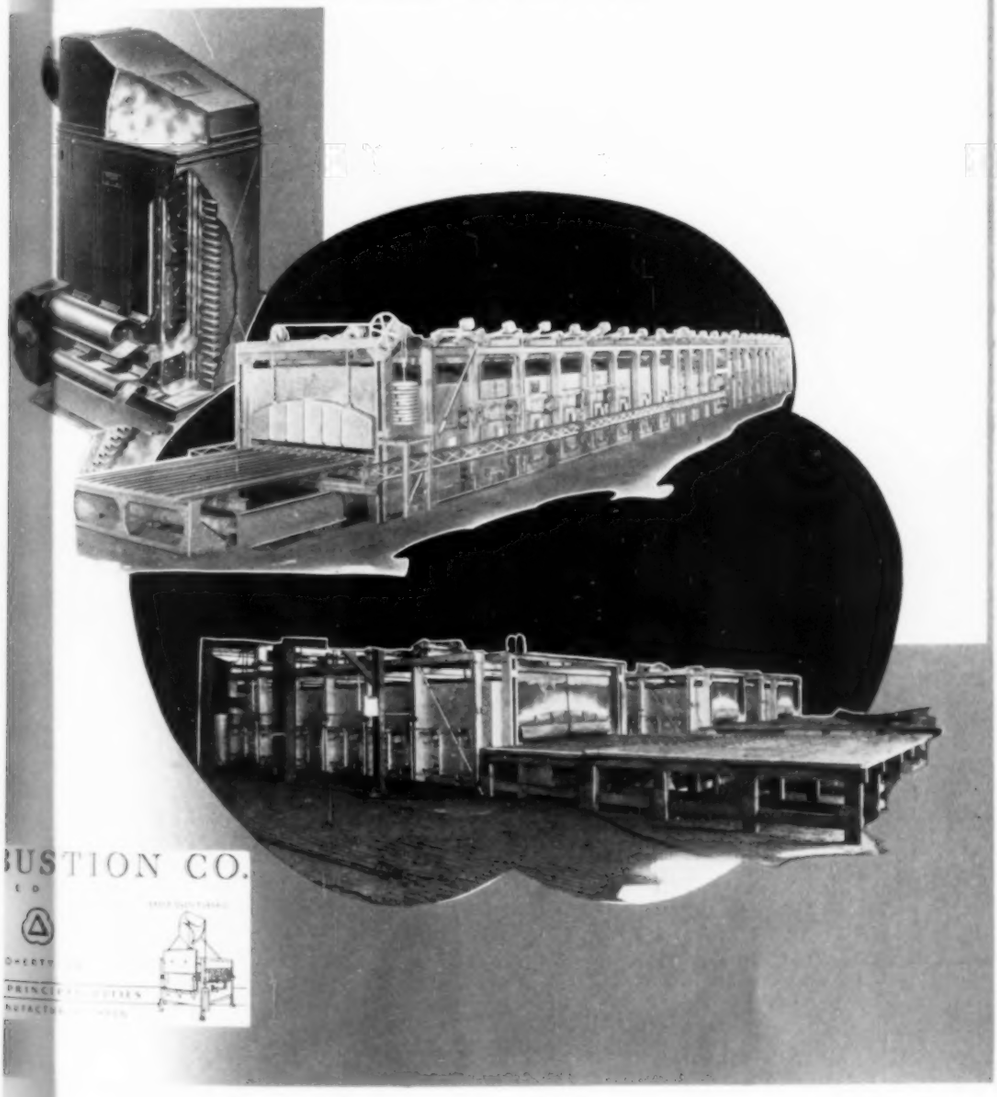

COMBUSTION

TESTING. Rules for Evaluation and Testing of D.C. Arc Welding Machines R.E.S.M./1931 (Regeln fuer die Bewertung und Pruefung von Gleichstrom - Lichtbogenschweissmaschinen R. E. S. M./-1931). Elektroschweissung *(Braunschweig)*, no. 5, May 1930, pp. 87-88.

Rules developed by professional committee for welding practice of Verband Deutscher Elektrotechnischer are given.

EXTENSOMETERS

ACOUSTIC. Precise Measurements of Stresses and Strains in Steel and Masonry Structures (Genaue Dehnungs- und Spannungsmessungen an Eisenkonstruktionen und Steinbauten), H. Hoffmann. *Bauingenieur (Berlin)*, vol. 11, no. 18, May 2, 1930, pp. 312-315, 2 figs.

Theory, construction and method of use of Schaefer acoustic extensometer, designed on basis of electromagnetic principles.

FURNACES

ANNEALING—CHARGING MACHINES. Charging Machine for Sixty-Foot Plates. *Iron Age*, vol. 125, no. 26, June 26, 1930, pp. 1884-1886, 4 figs.

Machine for handling plates 9 by 60 ft. maximum dimensions weighing up to 15 tons into and out of normalizing furnace built by Gibbons Brothers, Ltd., Dudley, England.

GAS, HIGH PRESSURE. High-Pressure Gas Heating (Pressgasbeheizung), F. Clemen. *Stahl und Eisen (Duesseldorf)*, vol. 50, no. 25, June 19, 1930, pp. 881-882, 1 fig.

Advantages of high-pressure over low-pressure gas firing are set forth; minimum required pressure for different kinds of gas is given, including blast furnace; producer, and mixed gases of all kinds, coke-oven and natural gas.

GALVANIZING. Zinc Alloys Destroy Galvanizing Pots, W. G. Imhoff. *Steel (formerly Iron Trade Rev.)*, vol. 87, no. 2, July 10, 1930, pp. 47-49, 3 figs.

Various types of failures are discussed and suggestions given for overcoming them.

(To be concluded)

HEAT TREATING. Form of Furnace for Heat Treatment, R. M. Keeney. *Metals and Alloys*, vol. 1, no. 13, July 1930, pp. 589-594, 5 figs.

Description and graphical illustration of effect of furnace forms on uniformity of chamber temperature, manner of heat application to charge, rate of heating, time of exposure, temperature control, atmosphere of furnace.

HEAT TREATING, GAS FIRED. The Super Gas Furnace. *Mech. World (Manchester)*, vol. 87, no. 2269, June 27, 1930, p. 607, 1 fig.

New type of gas-fired furnace constructed by Incandescent Heat Co. is fired by patent incandescent natural-draft adjustable jet gas burners, each under separate control, working in conjunction with multi-combustion chamber system; system of gas flow ensures even heating over entire working hearth, and also prevents infiltration of cold air into chamber, thus enabling heat treatment or carburizing to be carried out with minimum of scaling.

HEAT, GAS FIRED. Scholes-Incandescent Patent Plate-Heating Furnace at Consett Works, Durham. *Iron and Coal Trades Rev. (Lond.)*, vol. 121, no. 3253, July 4, 1930, pp. 1-2, 1 fig.

Method of charging and features of furnace designed for dealing with plates up to 45 ft. long by 9 ft. wide, furnace chamber being 46 ft. long by 10 ft. wide, capable of taking approximately 10 tons per charge; furnace is heated by coke-oven gas, which, together with air for combustion, are both slightly preheated.

MELTING, TILTING. Metal Melting in Large Tilting Furnaces. *Metal Industry (Lond.)*, vol. 37, no. 1, July 4, 1930, p. 14, 1 fig.

Continental firm of furnace manufacturers has produced coke-fired tilting furnace of 12½ cwt. capacity; they claim that charge of gun metal can be run down in one hour with fuel consumption of only 15 lb. of coke per 100 lb. of metal.

METALLURGICAL — PULVERIZED COAL. Pulverised-Fuel Firing for Metallurgical Work. *Metallurgia (Lond.)*, vol. 2, no. 8, June 1930, pp. 41-44, 7 figs.

Discussion of many advantages and wide application of pulverized fuel firing; examples of cost reductions.

FURNITURE

STAINLESS STEEL. Stainless Steel Furniture. *Times Trade and Eng. Supp. (Lond.)*, vol. 26, no. 624, June 21, 1930, p. 354.

One of directions in which newer industries have made great progress is production of stainless steel for furniture; some of uses to which it is being put at present time are; all metal furniture, more particularly for office and school use such as desks and chairs, table legs and pedestals, piano fittings, cabinet fittings, etc.

GRINDING

Form and Strength of Grinding Elements on High-Speed Grinding Tools (Form und Festigkeit von Einzelschleifkoerpern bei rasch umlaufenden Schleifwerkzeugen), C. Krug. *Maschinenbau (Berlin)*, vol. 9, no. 6, Mar. 20, 1930, pp. 199-201, 9 figs.

Investigation of grinding tools (disk form) fitted with separate grinding elements; new designs for laterally acting grinding elements are developed.

HARDNESS TESTING

Hardness by Mutual Indentation, I. H. Cowdrey. *Am. Soc. Testing Matls.—Advance Paper*, no. 52, for mtg. June 23-27, 1930, 12 pp., 7 figs.

Author has made use of both crossed and parallel cylinders and has shown that in each case simple linear function suffices to transform resultant data to Brinell hardness; this transformation constant appears to be independent of material, size, and proportions of test cylinders, and over reasonable range independent of pressure used.

CONVERSION TABLES. New Conversion Tables Show Relations Among Hardness Tests, T. N. Holden, Jr. *Iron Age*, vol. 126, no. 2, July 10, 1930, pp. 80-81.

Table compares hardness obtained with Rockwell using three loads, 150, 100 and 60 kg. with Brinell, diamond penetrator and scleroscope results.

HIGH SPEED STEEL

Mechanical Properties of High-Speed Steel at Elevated Temperatures, A. R. Page. *Metallurgia (Lond.)*, vol. 1, no. 6, Apr. 1930, pp. 239-241, 9 figs.

Report of research to determine properties; all tests were carried out under definite standard set of conditions; while results obtained are not absolute, it is claimed that they are comparative and give idea of variation in properties when material is heated.

IRON AND STEEL

Engineering Materials, v. 1; Ferrous, A. W. Judge. N. Y., Isaac Pitman and Sons, 1930. 683 pp., illus., diagrs., tables. $8.50.

Revision of Ferrous Volume of author's "Aircraft and Automobile Materials"; like that work, this one aims to give engineer and designer as distinct from metallurgist, information on available materials; physical and mechanical properties, heat treatments, compositions and applications are emphasized. Eng. Soc. Lib., N. Y.

CORROSION. Corrosion of Ferrous Metals (Le probleme de la corrosion des metaux ferreux), V. Sallard. *Annales des Postes Telegraphes et Telephones (Paris)*, vol. 19, no. 4, Apr. 1930, pp. 334-361, 5 figs.

External agents of corrosion; analysis of causes; opposing influences; high temperature resisting ferrous metals; comparison of Armco iron with other metals; solubility of copper and steel in various acids. Reprinted from Technique Moderne, Nov. 1, 1929.

MAGNETIC ANALYSIS. The Unbalanced Alternating Curret Bridge for Magnetic Analysis, W. B. Kouwenhoven and A. C. Seletzky. *Am. Soc. Testing Matls. — Advance Paper*, no. 37, for mtg. June 23-27, 1930, 14 pp., 6 figs.

Bridge has been developed which tests ferrous materials independent of their cross-sections; two coils and two resistances, one of which is variable, constitute four arms of bridge; standard specimen is placed in one coil and unknown specimen in other coil and galvanometer deflection is reduced to zero by varying resistance; specimens have been successfully tested, cross-sections of

CHROMIUM

High Carbon Ferrochrome (maximum 6% carbon)
Low Carbon Ferrochrome (in grades, maximum 0.06% to maximum 2.00% carbon)
Chromium Metal
Chromium-Copper
Miscellaneous Chromium Alloys

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Low Carbon Ferromanganese
Medium Carbon Ferromanganese
Manganese Metal
Silico-Manganese
Manganese-Copper
Miscellaneous Manganese Alloys

Electromet

SILICON

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Ferrosilicon 50%
Ferrosilicon 75%
Ferrosilicon 80 to 85%
Ferrosilicon 90 to 95%
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Calcium-Silicon
Calcium-Aluminum-Silicon
Calcium-Manganese-Silicon
Silicon-Copper
Silico-Manganese
Miscellaneous Silicon Alloys

VANADIUM

All Grades

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which varied from one-quarter to twice that of standard.

METALLOGRAPHY. The Iron and Steel Family, B. T. McMinn. *Heat., Piping and Air Conditioning*, vol. 2, no. 7, July 1930, pp. 566-570, 13 figs.

Consideration of composition and structure of irons and steels from heating, piping and air conditioning standpoint; characteristics of steel and cast steel; cold working; cast iron, gray and white.

METALLURGY. Elements of Ferrous Metallurgy, J. L. Rosenholtz. N. Y., John Wiley and Sons, 1930. 248 pp., illus. $3.00.

Fundamental principles and methods involved in manufacture and fabrication of iron and steel, with needs of civil and mechanical engineering students in mind, rather than those of prospective metallurgists; much detail is omitted, and special attention is paid to matters that affect mechanical properties of products; book is admirable introduction to subject. Eng. Soc. Lib., N. Y.

METALLURGY. American Iron and Steel Institute. *Engineering (Lond.)*, vol. 129, no. 3360, June 6, 1930, pp. 749-751, 5 figs.

Brief review of papers, as follows: chromium-manganese steels, F. M. Becket; steel house construction, L. H. Miller; steel specifications, J. Johnston; steel-plant lubrication, W. A. James; utilization of waste heat, C. W. E. Clarke; nickel iron and steel, C. McKnight; science and iron and steel industry, A. D. Little.

LOCOMOTIVES

FIREBOXES — CRACKING. Dressing of Heavy Sheets of Firebox and Trade Copper, V. G. Serdyakov. *Tzvetnige Metalli (Moscow)*, no. 4, Apr. 1930, pp. 516-530, 33 figs. partly on supp. plate.

Results of experience and tests in Russian locomotive plant; formation of cracks and its causes, with special reference to "hydrogen illness" as causative agent; methods of preventing crack formation. (In Russian.)

ROLLER BEARINGS. Locomotive Equipped with Roller Bearings, A. K. West. *Blast Furnace and Steel Plant*, vol. 18, no. 7, July 1930, pp. 1147-1148, 1 fig.

Application of roller bearings to 4-8-4 type locomotive built by American Locomotive Co. for Pennsylvania Railroad; total length, with tender, of 102 ft., and total weight of 711,500 lb., engine weight being 417,500 lb. and that of tender 294,000 lb.; has maximum speed of 85 m.p.h., and operates on two alternative steam pressures, 250 and 235 lb. respectively.

MAGNESIUM

The Magnesium Industry, J. A. Gann. *Indus. and Eng. Chem.*, vol. 22, no. 7, July 1930, pp. 694-700, 6 figs.

Occurrence of magnesium compounds; annual production of magnesium in United States since 1915; flow sheet for production of metallic magnesium; melting practice for magnesium alloys; corrosion resistance; quantities and uses. Abstract of paper read before Am. Inst. Chem. Engrs.

MALLEABLE IRON CASTINGS

Effects of Nickel Upon Malleable Cast Iron. *Metallurgia (Lond.)*, vol. 2, no. 8, June 1930, pp. 67-68.

Notes on experiments conducted by J. V. Murray, under research award from Staffordshire Iron and Steel Institute; tests were made on cupola-run metal and on casts from crucibles; best all-around mechanical results are found when nickel content is about one per cent.

Possibilities of Malleable Iron Castings, W. J. Molineux. *Metallurgia (Lond.)*, vol. 1, no. 6, and vol. 2, no. 1, Apr. 1930, pp. 242-244 and May 7, pp. 7-8.

Apr.: In considering future of malleable cast iron author refers briefly to birth of industry some 200 years ago, and deals with its subsequent growth and increased development in recent years. May: Future is very much in hands of founder himself, and present indications point to an increased demand, due chiefly to greater confidence; confidence has been obtained by pioneer founders, who have produced better articles by application of scientific principles to everyday practice.

METAL SPRAYING

Schoop's Metal Spraying Process in a New Form (Schoops metalliseringsmetod i ny form), A Salmony. *Teknisk Tidskrift (Stockholm)*, vol. 60, no. 24, June 14, 1930, pp. 375-376, 4 figs.

Apparatus for metallizing objects by spraying melted and carburized metal is described, apparatus was invented 26 years ago but is now greatly improved.

METALS

AGE HARDENING. Age-Hardening. *Metallurgist (Supp. to Engineer, Lond.)*, June 1930, pp. 81-82.

Wilm's discovery of age hardening in aluminum alloys was probably accidental to extent that he had no scientific or theoretical ideas to guide him; further development would have been slow had it not been for advanced workers studying abstruse equilibrium diagrams with meticulous accuracy; their work has converted empirical discovery of one important alloy into new field of development in which metallurgy of steel itself is now taking its share.

AGE HARDENING. Age-Hardening, M. L. V. Gayler. *Metallurgist (Supp. to Engineer, Lond.)*, June 1930, pp. 91-93.

Of theories put forward to explain age hardening, one which has gained most ground is precipitation theory which attributes age hardening to precipitation, in highly dispersed state, of particles from supersaturated solid solution; facts which have been established regarding changes which take place during age hardening are strong confirmation that hardening is due to precipitation of highly dispersed particles.

COLD HARDENING. Cold Hardening and Annealing of Metals and Alloys, (Remarques sur l'ecrouissage et le recuit des metaux et alliages), L. Guillet and J. Cournot. *Academie des Sciences—Comptes Rendus (Paris)*, vol. 190, no. 15, Apr. 14, 1930, pp. 905-908.

Papers by Guichard, Claussman and Billion published in earlier issues are discussed.

ELECTRIC CONDUCTIVITY. Effect of Pressure on Electrical Conductivity of Metals at Low Temperatures (Zur Druckabhaengigkeit der elektrischen Leitfaehigkeit der Metalle bei tiefen Temperaturen), U. Fischer. *Zeit. fuer Physikalische Chemie—Abteilung B (Leipzig)*, vol. 8, no. 3, June 1930, pp. 207-217, 3 figs.

Results of experimental determinations, made at laboratory of physical chemistry of University of Berlin, of electric conductivity of lead, tungsten, molybdenum, copper, iron and constantan, for temperatures as low as temperature of liquid hydrogen, and for pressures up to 180 kg. per sq. cm.

CORROSION. Corrosion and Stress. *Metallurgist (Supp. to Engineer, Lond.)*, June, 1930, pp. 82-93.

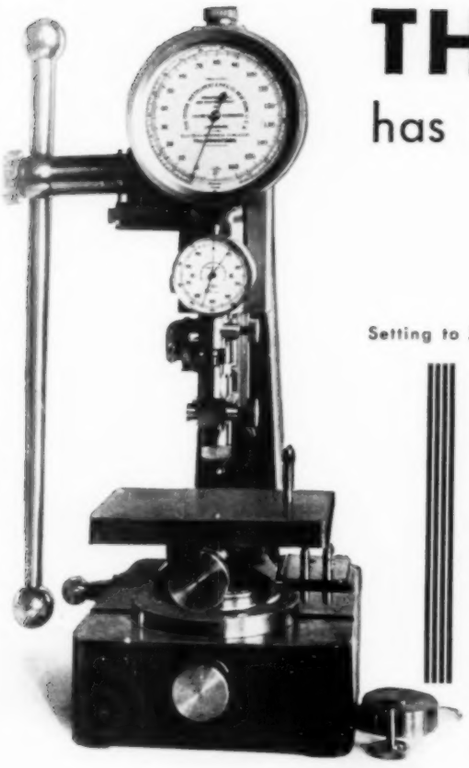
Emphasis is laid on importance of fact that stress is important factor in regard to corrosion; perhaps most striking evidence in that direction is associated with what has come to be known as corrosion fatigue following upon original discovery made by Haigh and subsequently very fully worked out by McAdam, that fatigue resistance of great majority of metals and alloys becomes very seriously reduced if surface of test piece is exposed to such mildly corrosive conditions as are produced by gentle stream of tap water.

CORROSION TESTING. New Process for Simultaneous Corrosion Testing of Different Metals (Ein neues Verfahren zur gleichzeitigen Korrosionskurzpruefung verschiedener Metalle), G. Gollnow. *Giesserei (Duesseldorf)*, vol. 17, no. 27, July 4, 1930, p. 665, 2 figs.

Details of electric process and equipment for measurement of corrosion of metals in solutions, developed by Toedt.

FATIGUE. Fatigue Strength and Tensile and Rupture Strength. W. Kuntze. *Metallurgist (Supp. to Engineer, Lond.)*, June 1930, pp. 94-95.

According to author rupture strength plays important part in fatigue phenomena; this property is defined as tensile strength when all deformation is prevented; procedure is to measure breaking tensile stress of number of specimens having circular notches of different depths and to extrapolate curve of maximum stress against area at



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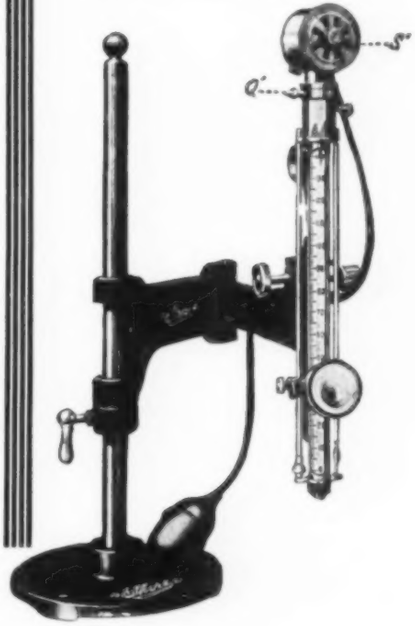

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base of notch to zero area. Translated abstract previously indexed from V. D. I. Zeit., Feb. 22, 1930.

FLOW. Flow Pressure of Metals and Alloys at Various Temperatures, V. P. Shishokin. *Tzvetniye Metalli (Moscow)*, no. 5, May 1930, pp. 662-671, 4 figs.

Results of experimental study of flow pressure of metals having low melting point, including tin, lead, cadmium, bismuth, etc.; empirical law of variation of flow pressure with temperature is derived; temperature coefficient of flow pressure is numerically equal to temperature coefficient of Brinell hardness. (In Russian.)

HARD FACING. Hard-Facing Metals—Their Applications, R. L. Lerch. *Welding*, vol. 1, no. 9, July 1930, pp. 613-614 and 633, 6 figs.

Examples of use in brick plants, cement plants, dredging, excavating and quarrying; gas and coke; iron and steel; lumber; general machinery; mining; oil well drilling; some savings effected by hard facing.

PASSIVITY. Passivation of Metal Surfaces by Impinging Electrons (Passivierung von Metalloberflaechen durch auftreffende Elektronen), F. Goldmann and E. Rupp. *Zeit fuer Physikalische Chemie—Abteilung B (Leipzig)*, vol. 8, no. 3, June 1930, pp. 180-186, 6 figs.

Report from Research Institute of General Electric Company of Germany (AEG) presenting experimental study of passivation of metal surfaces, with gas not extracted, by streams of fast electrons, as well as by ultra-violet light; passivation is apparently due to formation of oxide film.

PASSIVITY. Principles Underlying Theoretical Meaning of Passivity of Metals (Grundsaetzliches zur theoretischen Deutung der Passivitaet der Metalle), W. J. Mueller. *Zeit. fuer Elektrochemie (Leipzig)*, vol. 36, no. 6, June 1930, pp. 365-371, 2 figs.

Author replies to A. Smits' criticism of his work, previously indexed from Jan. 1930, issue of this journal. See references to original work published in 1929 issues of this journal in Engineering Index 1929, p. 1154. See also reply by A. Smits, pp. 371-375, 1 fig.

TEMPERATUREEFFECT. Some Metallurgical Problems Connected with the Possible Use of Very High Steam Temperatures, J. H. G. Monypenny. *Metallurgia (Lond.)*, vol. 2, nos. 7 and 8, May 1930, pp. 22-25 and June, pp. 46-48, 13 figs.

May: Creep or flow of metals at high temperatures; corrosion and erosion; general discussion of strength problem. June: Special difficulties likely to arise in some particular parts of high temperature steam equipment; superheater tubes; advantages of austenitic chromium-nickel steel over stainless irons; embrittlement of ordinary alloy steels. Bibliography.

METALS ANALYSIS

X-RAY. Use of X-Rays in the Aeronautic Industry, J. T. Norton. *Aviation*, vol. 28, no. 26, June 28, 1930, pp. 1261-1263, 7 figs.

Development of testing metal by X-ray and outline of actual and potential applications of method in aeronautics; testing of castings and welds; X-ray photographs illustrate typical flaws.

X-RAY. Materials Testing, by Means of X-Rays (Werkstoffpruefung mittels Roentgenstrahlen in der Metall verarbeitenden Industrie), K. Becker. *Maschinenbau (Berlin)*, vol. 9, no. 6, Mar. 20, 1930, pp. 193-198, 23 figs.

Typical application of X-ray analysis in metal industry; testing for cavities, slag, and other flaws, heat treatment of wires and sheets can be investigated; notes on design and operation of apparatus.

X-RAY. The Application of X-Rays to the Study of Metals, J. B. Friauf. *Rev. of Sci. Instruments*, vol. 1, no. 7, July 1930, pp. 361-396, 14 figs.

Discussion of three ways in which X-rays are used in metallurgy; use of X-rays for radiographic examination of metals, for determination of chemical composition by methods of X-ray spectroscopy, for study of crystalline structures of metals. Bibliography.

X-RAY. A Study of Crystal Structure and Its Applications, T. A. Wilson. *Gen. Elec. Rev.*, vol. 33, no. 7, July 1930, pp. 412-416, 7 figs.

Calculation of orientation from symmetrical Laue photographs. (Continuation of serial.)

METALS TESTING

Testing of Materials in France (Quelques Progres Recents des Methodes de Controle des Produits Metallurgiques), M. P. Nicolau. *Societe D' Encouragement pour l'Industrie Nationale—Bul. (Paris)*, vol. 129, no. 2, Feb. 1930, pp. 117-150, 19 figs.; see also translated abstract in *Metallurgist (Supp. to Engineer)*, June 27, 1930, p. 84.

Some decidedly striking contrasts with British point of view and divergences of practice are found; Modern British, German, and American work appears to be entirely ignored; criticism of tensile testing machines and methods; greatest importance is attached to shock test.

METALLURGY

Some Factors of Solidification in Relation to Metallurgical and Geological Problems. *Chem. Met. and Min. Soc. of S. Africa—Jl. (Johannesburg)*, vol. 30, no. 10, Apr. 1930, pp. 292-301 and (discussion), 301-303.

Broad discussion of behaviour of metals in cooling and solidification; physical reactions in cupellation of bullion; solidification of ore metals and minerals from molten magma; segregation.

MINES AND MINING TERMINOLOGY

Mining Methods and Systems, T. T. Read. *Min. and Met.*, vol. 11, no. 283, July 1930, pp. 336-338.

Professor of Mining at Columbia University deplores lack of system in customary terminology in mining industry; this fact constitutes unnecessary handicap to students in mining schools; examples are given from cited literature; suggestions are given and are invited.

NITRIDATION

Iron-Nitrogen System (Das System Eisen-Stickstoff), O. Eisenhut and E. Kaupp. *Zeit. fuer Elektrochemie (Leipzig)*, vol. 36, no. 6, June 1930, pp. 392-404, 15 figs.

X-ray analysis to determine phase limits, solubility curves, eutectoid curves, and temperature; results show existence of four homogeneous phases, continuous absorption of nitrogen in different phases with change of crystal-grid constants, and formation of nitrogen martensite. Bibliography.

Nitrogen Case-Hardening of Steel by The Homo Method. *Metallurgia (Lond.)*, vol. 2, no. 7, May 1930, pp. 32 and 36, 1 fig.

Nitridation process is stated by anonymous author as being commonly referred to as "nitration"; no nitrates are used and none are formed, but process consists in subjecting machined, and preferably heat treated, articles to ammonia gas under certain conditions, resulting in remarkable surface hardness being imparted without any further heat treatment; development is credited to A. Fry; description of furnace equipment and practice.

NITRIDED STEEL

FATIGUE. A Note on Fatigue Tests of Nitrided Steel, N. L. Mochel. *Am. Soc. Testing Matls.—Advance Paper*, no. 42, for mtg. June 23-27, 1930, 5 pp., 5 figs.

Fatigue test data on chromium-aluminum-molybdenum steel, before and after hardening by nitriding process; tests were made on rotating cantilever specimens; data are also given as to chemical composition and tension, impact, and hardness characteristics of material used.

NON-FERROUS ALLOYS

STAMPING. Drop Stamping Non-Ferrous Alloys, K. Napier. *Metallurgia (Lond.)*, vol. 1, no. 5, Mar. 1930, pp. 192-194 and 214, 4 figs.

Drop stamping of non-ferrous alloys is recent development, copied from drop stamping of steel; distinction is made between hot pressing and drop stamping; copper-base alloys and aluminum-base alloys are separately discussed; type of furnace; choice of material; extruded bar is considered best stock for non-ferrous stampings; ingots can be used, but should be hot worked before stamping is attempted; annealing at 250 deg. Cent. is advised as remedy for season cracking.

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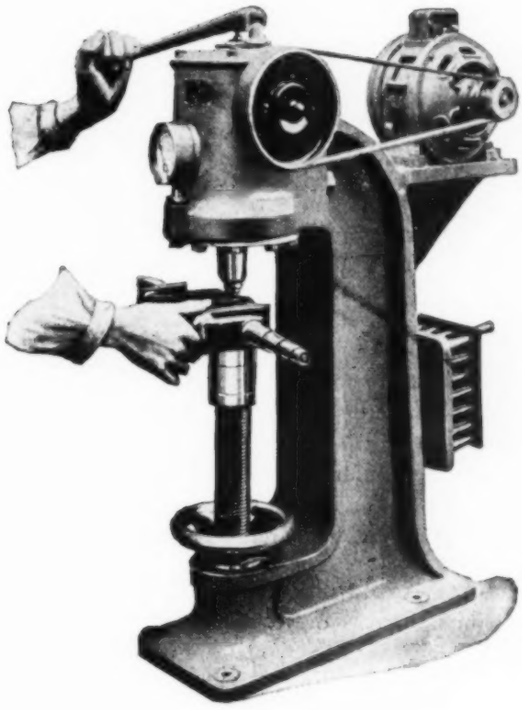

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STAMPING. Drop Stamping Non-Ferrous Alloys, K. Napier. *Metallurgia (Lond.)*, vol. 1, no. 6, Apr. 1930, pp. 245-246, 3 figs.

Discussion of aluminum alloys; aluminum-copper-magnesium type is popular, due to mechanical properties, lightness, resistance to corrosion, ease of manipulation, etc.; details of stamping practice with particular reference to this type; electric heating furnaces are best, with gas as best substitute; grain flow; heat treatment; pickling and scratch bruising, to remove scale.

NON-FERROUS METALS

CRITICAL POINTS. Critical Points of Metals (Ueber die Umwandlungspunkte von Metallen), A. Schulze. *Zeit. fuer Metallkunde (Berlin)*, vol. 22, no. 6, June 1930, pp. 194-197, 5 figs.

Results of systematic investigation of especially pure materials to determine electric conductivity, heat capacity, and heat expansion of zinc, bismuth, thallium and cobalt.

DRAWING. Use of Compressed-Air Blank Holders in Drawing of Non-Ferrous Metals (Verwendung von Druckluft-Faltenhaltern bei Bearbeitung von Nichteisenmetallen), O. Kuehner. *Zeit. fuer Metallkunde (Berlin)*, vol. 22, no. 6, June 1930, pp. 190-193, 9 figs.

Deep drawing of non-ferrous metals is discussed; through special design of blank holder, stress of thin sheets in deep drawing can be limited to such extent that sheets do not tear.

HARDNESS. Brinell, Rockwell and Scleroscope Hardness of Non-Ferrous Metals (Brinell, Rockwell und Skleroskophaerte bei Nichteisenmetallen), O. Schwarz. *Zeit. fuer Metallkunde (Berlin)*, vol. 22, no. 6, June 1930, pp. 198-202, 7 figs.

Comparison of action of these three hardness-testing methods as applied to rolled metals; suggestions for their practical applications, also in case of drawn metals.

INDUSTRY. International Non-Ferrous-Metal Industry (Die internationale Nichteisen-Metallwirtschaft im Jahre 1929), S. Kugelmann. *Internationale Bergwirtschaft und Bergtechnik (Halle)*, vol. 23, no. 9, May 15, 1930, pp. 143-147.

Data covering five main metals; copper, tin, lead, zinc, and aluminum based on statistics and direct observation; relation between supply and demand and influence of cartel on metal trade.

LIGHT. Report of Committee B-7 on Light Metals and Alloys, Cast and Wrought. *Am. Soc. for Testing Matls.—Advance Paper* no. 23, for mtg. June 23-27, 1930, 11 pp., 1 fig.

Proposed tentative specifications for aluminum-alloy (duralumin) sheet; aluminum-manganese alloy sheet; magnesium-base alloy sand castings.

Treatment of Light Metals (Die werkstattmaessige Behandlung der Leichtmetalle), F. Gentzcke. *Maschinenbau (Berlin)*, vol. 9, no. 12, June 19, 1930, pp. 415-418, 4 figs.

Description of hot and cold forming and drawing, forging and bending; notes on heat treatment and equipment; data on machining, feed tool shape, and cutting angle; light metal rivet and steel rivets are compared; review of metals for surface protection.

SPECIFICATIONS. Report of Committee B-2 on Non-Ferrous Metals and Alloys. *Am. Soc. Testing Matls.—Advance Paper No.* 19, for mtg. June 23-27, 1930, 14 pp., 7 figs.

Principal activity of Committee has been centered in Subcommittee XV on Die-Cast metals and Alloys and in Subcommittee VII on methods of chemical analysis; no recommendations affecting standards or tentative standards are being made; appendix contains contribution on metallography of zinc-base die-casting alloys, by W. M. Pierce.

OPEN-HEARTH FURNACE PRACTICE

Qualifications and Duties of Open-Hearth Melter, M. J. Conway. *Iron Age*, vol. 125, no. 2, July 10, 1930, pp. 78-79.

Topics discussed concern design and operation of furnace, duties of each workman, how he can improve his own position and overall costs of steel making, and lessen danger of off-heats.

Open-Hearth Furnace Control Discussed at Symposium in Buffalo. *Iron Age*, vol. 125, no. 26, June 26, 1930, pp. 1889-1890, 2 figs.

Brief review of papers by R. W. Simpson, Bradley, and J. F. Shadgen presented before Association of Iron and Steel Electrical Engineers.

OXYACETYLENE CUTTING

Autogenous Cutting of Structural and Alloy Steels (Ueber das autogene Schneiden von Baustaehlen und Legierten Staehlen). *Autogene Metallbearbeitung (Halle)*, vol. 23, no. 12, June 15, 1930, pp. 182-191, 10 figs.

Report on investigation of various kinds of steel regarding difference in hardness between cut surface and unchanged materials; test data are given and illustrated by graphs. (Continuation of serial.)

OXACETYLENE WELDING

RAILROAD REPAIR SHOPS. The Oxyacetylene Welding Process in Railway Shops, F. S. Tinder. *Welding*, vol. 1, no. 9, July 1930, pp. 602-605, 6 figs.

It is pointed out that proper training of welders and supervision are essential factors for continued growth of welders; correct preheating and annealing most important.

PIPE, CAST IRON

CENTRIFUGAL CASTING. Casts Pipe Centrifugally in Sand Molds, P. Dwyer. *Foundry*, vol. 58, no. 13, July 1, 1930, pp. 98-102, 9 figs.

Manufacturing equipment and methods of American Cast Iron Pipe Co., Birmingham, Ala.; notes on green-sand molds and handling of sand. (Continuation of serial.)

PRESSURE VESSELS WELDING

Welding of Super Code Pressure Vessels, L. H. Burkhart. *Am. Welding Soc.—Jl.*, vol. 9, no. 6, June 1930, pp. 28-32, 3 figs.

Welding procedure for vessels larger than 60 in. diam. for more than 200 lb. pressure and which may employ unit stress more than 8000 lb. per sq. in. of weld section: results of tests of procedure.

PUMPS OXYACETYLENE WELDING

Welding in the Manufacture of Pumps, C. H. S. Tupholme. *Mech. World (Lond.)*, vol. 87, no. 2268, June 20, 1930, pp. 583-584, 5 figs.

Experiences of firm of Gould's Pumps, Inc., Seneca Falls, New York, where extensive use is made of oxyacetylene welding.

PUNCH PRESS PRACTICE

Assembling 4440 Fittings per Hour. *Machy. (N. Y.)*, vol. 36, no. 11, July 1930, pp. 873-874, 3 figs.

Automatic equipment used for assembling balls and springs into lubricator fittings at high speed, without hand operations, employed by Alemite Corp., Chicago, Ill.

RAILS-ARC WELDING

Electrical Rail Reclamation. *Railroad Herald*, vol. 34, no. 6, May 1930, pp. 26-28, 3 figs.

Brief description of new application of arc welding process which is expected to add many years of usefulness to worn rail, and to help reduce maintenance work.

REFRACTORY MATERIALS TRADE NAMES

Trade Names in Refractory-Material and Furnace Industries (Markenbezeichnungen im Feuerfest-Fach und Ofenbau). *Feuerfest (Leipzig)*, no. 5, May 1930, pp. 67-70.

Alphabetically arranged list of German and foreign trade names of interest to furnace manufacturer and other industries employing refractory products.

ROCK DRILLS, PNEUMATIC

TESTING. Machines for Testing Efficiency of Pneumatic Tools, Particularly Rock-Drilling Machines (Provningsmaskiner for utprovande av pneumatiska verktygs effekt med sarskild hansyn tagen till utprovandet av bergborrmaskiner), L. Nordenfeldt. *Teknisk Tidskrift (Stockholm)*, vol. 60, no. 24, June 14, 1930, *(Bergsvetenskap)* pp. 41-43, 5 figs.

Principle of machines, efficiency, and reliability are discussed.

ROLLING MILL PRACTICE

Theory of Rolling of Plastic Materials, F. G. Gasche. *Iron and Steel Engr.*, vol. 7, no. 6, June 1930, pp. 325-339, 14 figs.

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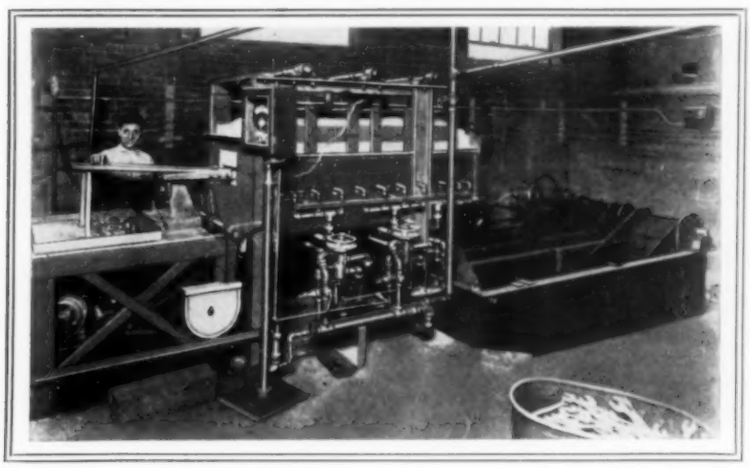

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- Cyanide Furnaces
- Cylindrical Furnaces
- Forges
- Forges, Glass Bending
- Heat Exchangers, Thermo Syphon
- Heating Machines
- Melting Furnaces
- Muffle Furnaces
- Oil-Tempering Furnaces
- Oven Furnaces
- Rivet Heaters
- Soldering Iron Heaters
- Soft Metal and Lead Hardening Furnaces
- Sweep Reducing Furnaces
- Textile Appliances for Drying and Singeing
- Tube-Heating Furnaces
- Every Type of Gas Blast Burner, Furnace and Heating Machine for Industrial Uses

Rolling operation explained; work due to elongation or compression of block of plastic material; energy demands of roll collar action; abrasions of surfaces parallel to roll axis; roll neck friction; friction of bearings and mechanism of four-high plate mills and cluster rolls; application of theory to design of motor drive for 34-in. reversing blooming mill; strength and stiffness of rolls; work done in twisting plastic bars.

ROLLING MILLS

Strip Rolling Mills, W. W. Robertson. *Metallurgia (Lond.)*, vol. 2, no. 7, May 1930, pp. 4-6, 3 figs.

Discussion of types of mills for strip rolling; factors determining size of roll to be used; advantages of roller bearings; description of new types of equipment; advantages and disadvantages of backed-up, two high, cluster, and other types of mills.

BILLET GRINDING. Compensating Costs in Grinding Varied Size Billets, L. C. Griffin. *Abrasive Industry*, vol. 11, no. 7, July 1930, pp. 20-21, 3 figs.

Method by which tonnage ground in billet-grinding departments steel mills can be figured on fair basis.

DESIGN. Roll Pass Design, W. Trinks. *Rolling Mill*, vol. 4, nos. 5 and 6, May 1930, pp. 241-244 and June, pp. 295-296, 10 figs.

May: Discussion of causes and effects of thrust in symmetrical and non-symmetrical roll passes; calculation of end thrust. June: Discussion of method for determining bearing area which takes end thrust due to rolling in non-symmetrical passes. Abstract of paper read before Carnegie Institute of Technology.

ROLLS, CHILLED

Modern Chilled Iron Rolls, W. H. Melaney. *Rolling Mill*, vol. 4, nos. 5 and 6, May 1930, pp. 237-240 and June, pp. 291-293.

May: Structures which compose chilled iron rolls, and their service characteristics. June: Essential characteristics of rolls and their selection for various classes of product. (Continuation of serial.)

HARDNESS. Does the Scleroscope Give the True Hardness of Chilled Rolls, J. Shaw. *Metallurgia (Lond.)*, vol. 1, no. 5, Mar. 1930, pp. 217 and 220.

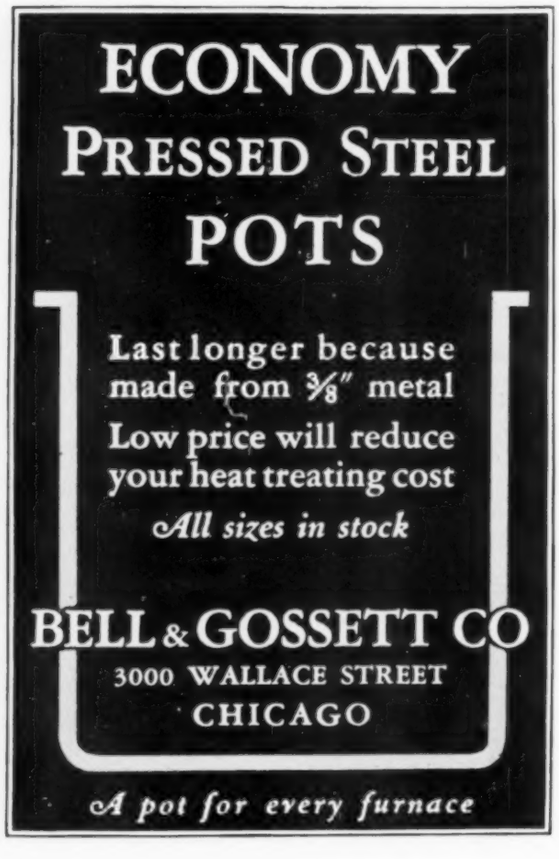
Discussion consisting chiefly of quotations from papers by O. Keune and by W. H. Melaney, previously indexed from *Kruppsche Monatshefte*, Dec. 1929 and from *Blast Furnace and Steel Plant*, Jan. 1930, respectively; basing opinion also on examples of personal observation, author concludes that it is impossible to rely on figures obtained by scleroscope on chilled rolls; Brinell test is not suitable as it leaves imprints that would mark paper sheets to textile fabric.

SHEET METAL

CURLING. Curling of Sheet Metal at High Temperatures (Ueber die Schrumpfungskraft der Blattmetalle bei hoher Temperatur), I Sawai and M. Nishida. *Zeit. fuer anorganische und allgemeine Chemie (Leipzig)*, vol. 190, no. 4, June 17, 1930, pp. 375-383, 9 figs.

Theoretical and experimental study of curling of gold and silver sheets 0.0031-0.0077 mm. thick, at temperatures of 600-1400 deg. Cent., beyond melting point surface tension of metals was measured; curling force determined by equilibrating it with mechanical load.

SHEET MILL PRACTISE

Manufacture of Automobile Sheet Metal (Die Herstellung von Kraftwagenblechen), W. Kraemer. *Stahl und Eisen (Duesseldorf)*, vol. 50, no. 28, July 10, 1930, pp. 991-996, 6 figs.

Use of hot and cold-rolling processes in Germany; chemical and physical properties of material; cold-rolling process and equipment employed; design of mills; treatment of sheets by annealing in single-box and tunnel ovens and by polishing; comparison between hot and cold rolling processes.